integral to or physically separate from chip 22 and that window 16 may be formed anywhere on surfaces 12 and/or 14 as will accomplish the purposes of the invention.

Specifically, a card in accordance with the present invention has a thickness of approximately in the range of 0.028 inches to 0.032 inches with a surface smoothness of 0.0005 inches. In order to meet the ISO standards for such cards, these tolerances apply to the surface of the microprocessor chip 22 surface as well as to the surface of plastic portion of card **10**. It is to be appreciated that cards having a thickness greater than 0.032 inches can easily be manufactured in accordance with the teachings herein while meeting all of the other criteria of the present invention. However, the foreseen product demand is for cards meeting the aforementioned standards.

As shown in FIG. 4, one or more cards **10** in accordance with the present invention may be manufactured by positioning an electronic element **20**, including contact points **26**, between first and second sheets of card stock **30**, **32** to form a core **33**. Preferably as shown, a plurality of cards are manufactured simultaneously, and accordingly a plurality of electronic elements **20** are positioned between the first and second sheets of plastic core stock **30**, **32**. When a plurality of electronic elements **20** are positioned between first and second sheets plastic core stock **30**, **32**, electronic elements **20** are properly positioned relative to one another such that a plurality cards may be cut from the resulting card stock.

Plastic core sheets **30**, **32** may be provided by a wide variety of plastics, the preferred being polyvinyl chloride (PVC) having a thickness in the range of 0.007 inches to 0.024 inches and preferably having a thickness of approximately 0.0125 inches each. Those skilled in the art will recognize that the thickness of the plastic core sheets will depend somewhat upon the thickness of the one or more electronic elements that are to be embedded therebetween if ISO standards are intended to be met. Other suitable plastics that may be utilized include polyester, acrylonitrile-butadiene-styrene (ABS), and any other suitable plastic.

Subsequent to placing one or more electronic elements **20** between the first and second sheets **30**, **32** of plastic core stock to form a core **33**, this core **33** is placed in a laminator apparatus **40** of the type well known in the art of plastic card manufacturing. As is shown in FIG. 5, laminator **40** includes upper and lower platens **42**,**44** for applying ram pressure to an article positioned therebetween. In addition to the ability to apply ram pressure, laminator **40** is preferably of the type having controlled platens **42**,**44** that may provide both heat and chill cycles and preferably includes cycle timer to regulate cycle time. Core **33** is positioned between first and second laminating plates **50**, **52**, one of which is preferably matte finished to provide laminated core **33** with at least one textured outer surface. First and second laminating pads **60**, **62** are positioned outside of the laminating plates **50**, **52**, and first and second steel plates **70**, **72** are likewise positioned outside of pads of **60**, **62** and the entire assembly forms a book **37** for being positioned in laminator **40** between platens **42**, **44**.

Once book **37** is positioned in laminator **40** as shown in FIG. 5, the first lamination cycle is initiated by closing laminator platens **42**, **44**, preferably applying little or no ram pressure to book **37**. This is preferably done using hydraulic pressure, and a pressure not to exceed about 10 pounds per square inch is believed sufficient for most applications.

A laminator heat cycle is initiated, bringing the temperature of platens **42**,**44** up to a range of 275° F. to 400° F., and most preferably up to a range of 300° F. to 370° F. for a period of ranging between 1 to 20 minutes, but preferably greater than 5 minutes, and most preferably in the range of 7 to 10 minutes for PVC material. It must be understood that the temperatures recited herein are by means of example. The use of thermoplastic material other than PVC or the presence of pigments in the core material may require modification of the heat cycle temperature.

Once the heat cycle has been applied to book **37** as is set forth above, the ram pressure of laminator **40** is increased to facilitate the flow of the plastic core sheets **30**, **32** so that the one or more electronic elements **20** become encapsulated thereby, and so that sheets **30**, **32** form a uniform core **33** with upper and lower surfaces **34**,**35**. The ram pressure translates into an effective pressure on core **33** in the range of 200 to 450 psi and preferably in the range of 250 to 350 psi. As can be expected temperature and pressure are inversely related to one another. In other words a lamination cycle at a higher temperature will require less pressure to be applied to core **33**, and conversely a lower temperature heat cycle will require increased ram pressure. Damage to the electronic components can result from excessive ram pressure on the core while insufficient ram pressure will likely cause an inadequate flow of the plastic resulting in air pockets or an irregular card surface.

As mentioned, the use of matte finished laminator plates **50**,**52** provides surfaces **34**, **37** with a slightly roughened or textured quality which will facilitate the application of a coating thereto as is discussed below. The ram pressure applied during the heat cycle and the length of the heat cycle may vary, depending especially upon the size of sheets **30**, **32**. For example, the cycle time may be in the range of 10–15 minutes. In one example, at a temperature of approximately 320 degrees Fahrenheit, a ram pressure of 940.135 pounds per square inch (p.s.i.), producing a pressure of about 275 psi at the core **33** surface, was applied for 10–15 minutes to form a uniform core **33**, using sheets **30**,**32** of a size in the range of 12 inches by 24 inches to 24 inches by 36 inches.

Subsequent to the above heat cycle, laminator **40** applies a chill cycle to book **35** during which time the ram pressure of the laminator **40** is increased, preferably by approximately 10–40% and most preferably about 25% until the platens **42**,**44** have cooled so as to return the core material to a solid state. In the preferred method the platens **42**, **44** are cooled to approximately 40° F. to 65° F. for approximately 10–15 minutes. Core **33** may then be removed from laminator **40** for additional processing.

Subsequent to the removal of core **33** from laminator **40**, and as illustrated in FIG. 6, core **33** is coated on at least one of its upper and lower surfaces **34**, **35** with a layer of printing ink **36**. This may be accomplished using a wide variety of printing techniques such as offset printing, letterpress printing, screen printing, roller coating, spray printing, lithoprinting, and other suitable printing techniques. As shown in FIG. 6, core **33** is fed in the direction indicated with arrow A through a printing press, a lithographic printer, or a similar apparatus **80**. This printing step is performed to coat at least one surface **34**, **35** of core **33** with a layer of aesthetically pleasing ink **36**. This layer of ink **36** can also serve to cosmetically hide the one or more electronic elements **20** that are embedded within core **33**, and prevent these one or more electronic elements **20** from showing through the relatively thin core **33**. In this manner, the one or more electronic elements **20** encapsulated in core **33** are completely hidden from view without requiring the plastic used in the manufacture core **33** to be excessively thick (exceeding ISO standards for cards of this type).

Referring now to FIG. 7, the final preferred, but optional processing of core **33**, which now comprises a layer of ink

36 or the like on at least one surface 34, 35 thereof, is schematically illustrated. An overlaminate layer such as clear overlaminate film 38 is positioned on at least one ink coated surface 34, 35 of core 33, and preferably core 33 is positioned between two similar sheets of overlaminate film 38,39 as shown. Overlaminate film is very thin, for example in the range of 0.0015" thick. A book 135 is then constructed for insertion into laminator 40 as is schematically illustrated in FIG. 7. Book 135 comprising core 33, including at least one layer of ink 36 and at least one layer of overlaminate film 38, 39 is positioned between laminating plates which are preferably highly polished plates such as mirror finished stainless steel plates 91, 92. Book 135 also comprises first and second laminating pads 60, 62 and first and second steel plates 70, 72 as is discussed above in relation to FIG. 7.

When book 135 is positioned between upper and lower platens 42, 44 of laminator 40 as shown in FIG. 7, the laminator is closed and a heat cycle in the range of 175° F. to 300° F., and most preferably in the range of 180° F. to 275° F., is applied to book 135 for a period of 10 to 25 minutes to produce a pressure on book 135 of between 200 to 450 psi, preferably 250–350 psi, with a ram pressure that varies depending upon sheet size or the ram size of the laminator 40, but which is typically approximately 1000 p.s.i. with an 18 inch diameter ram. This step causes the overlaminate layer 38 to flow in order to produce a uniform protective layer over the printing.

The laminator 40 is then caused to execute a chill cycle, preferably with a corresponding increase in ram pressure. For example, the chill temperature may be in the range of 40° F. to 65° F. and last for a period of 10 to 25 minutes. However, any combination of temperature and time which permits the re-solidification of the overlaminate layer 38 may be used. A ram pressure increase of approximately 10 to 40% over the pressure used for the heat cycle has been found to be preferable, with a pressure increase of approximately 25% being most desirable.

It is important to note that the use of pressure, or more significantly temperature, in the second lamination cycle should only affect the overlaminate layer 38 and should not cause softening or re-flow of plastic core 33. In lieu, of this preferred overlamination process, it is to be understood that colorfast inks may not require an overlaminate layer or that alternative overlaminates such as those applied by spray, silk screening or roll on may be used.

Subsequent to the above described second lamination cycle, a sheet of plastic card stock is provided which comprises at least core 33 with at least one surface 34, 35 thereof covered by a layer of ink 36, and with at least one surface 34,35 thereof covered by a layer of overlaminate film 38, 39.

Preferably plastic card stock manufactured in accordance with the present invention comprises core 33 covered on both surfaces 34, 35 with a layer of ink 36 which is positioned between layers of overlaminate film 38, 39, all of which has been laminated together as described and as shown in FIG. 8. One or more cards 10 then may be cut from the resulting plastic card stock and card 10 will have a thickness in the range of 0.028 inches to 0.032 inches with variation in overall thickness across the surfaces 12, 14 thereof being no greater than approximately 0.0005 inches. The one or more cards 10 can thus be said to have a glossy surface smoothness of approximately 0.0005 inches or better. Thus, a card 10 manufactured in accordance with the present invention includes at least one surface 12, 14 at preferably both surfaces 12,14 that are sufficiently smooth, glossy and regular to receive dye sublimation printing.

In the preferred embodiment, each card 10 undergoes a controlled-depth milling operation to form a window or cavity 16 and to expose one or more of the contact pads 26 connected to the antenna 24. Thereafter, a microprocessor chip 22 having a contact surface is inserted into the cavity and in electronic contact with contact pads 26. Chip 22 may be attached to contact pads 26 by known means such as conductive adhesives (including those cured by UV or sonic energy) or low temperature solder. The overall thickness of the card including the area occupied by chip 22 meets ISO standards and is capable of operation in compatible physical readers.

In an alternative embodiment, a cavity or window 16 is formed in the first or second sheet of plastic core stock, prior to the first lamination step. The core stock is positioned over the electronic element, generally 20, to expose one or more contact pads 26. This may also be done using electronic elements wherein microprocessor chip 22 is already attached to contact pads 26 and/or antenna 24 in which case the cavity is positioned over and around chip 22. As shown in FIG. 5*a*, a spacer 90 is inserted into cavity 16 and over contact pads 26 or chip 22. The spacer 90 may be integral to one of the matte laminating plates 50, 52 or separate therefrom and made of any suitable non-stick material such as Teflon®. Spacer 90 is utilized to prevent or limit the flow of plastic into cavity 16 during the lamination process so as not to cover contact pads 26 or chip 22 with plastic. When spacer 90 is non-integral with matte laminating plate 50 or 52 it may be removed or cut-away after either the lamination or overlamination process to expose cavity 16 and allow microchip 22 to be inserted therein and retained by such means as are known in the art, including solder or adhesives. In this embodiment where the chip is installed prior to lamination, when viewed in cross-section the outer surface of chip 22 is below the upper surface 34 or core sheet 35 prior to lamination, thus core sheets will accept the majority of applied pressure from the laminator. Spacer 90 provides further protection. As the core material softens, the plastic will flow around spacer 90 and chip 22 and the distance between the outer surface of chip 22 and the upper surface of core sheet 35 will decrease.

Those skilled in the art will recognize that the foregoing description has set forth the preferred embodiment of the invention in particular detail and it must be understood that numerous modifications, substitutions, and changes may be undertaken without departing from the true spirit and scope of the present invention as defined by the ensuing claims. For example, it should be understood that the methods as described can be performed with or without the printing or coating steps and still fall within the scope of the invention.

What is claimed is:

1. A process for incorporating at least one electronic element in the manufacture of a plastic card, comprising the steps of:

(a) providing first and second plastic core sheets:

(b) positioning said at least one electronic element in the absence of a non-electronic carrier directly between said first and second plastic core sheets to form a core, said plastic core sheets defining a pair of inner and outer surfaces of said core;

(c) positioning said core in a laminator apparatus, and subjecting said core to a heat and pressure cycle, said heat and pressure cycle comprising the steps of:

(i) heating said core for a first period of time;

(ii) applying a first pressure to said core for a second period of time such that said at least one electronic element is encapsulated by said core;

(iii) cooling said core while applying a second pressure to said core, the second pressure being at least 10% greater than the first pressure; and

(d) milling a region of said core to a controlled depth so as to form a cavity which exposes at least one contact pad of said at least one electronic element.

2. The process for incorporating at least one electronic element in the manufacture of a plastic card as recited in claim 1, wherein said laminator apparatus has first and second laminating plates, at least one of said first and second laminating plates having a matte finish for creating a textured surface on at least one of said outer surfaces of said core.

3. The process for incorporating at least one electronic element in the manufacture of a plastic card as recited in claim 2, wherein each of said first and second laminating plates has a matte finish for creating said textured surface on both of said outer surfaces of said core.

4. The process for incorporating at least one electronic element in the manufacture of a plastic card as recited in claim 1, wherein said first and second plastic core sheets are made from a material selected from the group consisting of polyvinyl chloride, polyester, and acrylonitrile-butadiene-styrene, each of said sheets having a thickness in the range of 0.007 to 0.024 inch.

5. The process for incorporating at least one electronic element in the manufacture of a plastic card as recited in claim 4, wherein said first and second plastic core sheets have a thickness of approximately 0.0125 inch.

6. The process for incorporating at least one electronic element in the manufacture of a plastic card as recited in claim 1, wherein said second pressure ranges from about 10% to about 40% greater than said first pressure.

7. A process as recited in claim 1 having a further step following step(c), said step comprising: positioning a layer of overlaminate film on at least one of said surfaces of said core, positioning said overlaminate film and said core in a laminator apparatus and laminating said layer of overlaminate film to said core in said laminator to thereby form a sheet of plastic card stock.

8. The process of claim 7, further comprising the step of coating said at least one surface of said core with a layer of ink prior to positioning said overlaminate film on said at least one surface of said core.

9. The process for incorporating at least one electronic element in the manufacture of a plastic card as recited in claim 1, wherein said core is heated in step (c)(i) to a temperature in the range of 275° F. to 400° F. and said first period of time is at least five (5) minutes.

10. The process for incorporating at least one electronic element in the manufacture of a plastic card as recited in claim 1, wherein said first pressure is approximately 450 p.s.i. and said second period of time is at least 10 minutes.

11. The process for incorporating at least one electronic element in the manufacture of a plastic card as recited in claim 1, wherein a coating step is carried out on at least one surface of said core utilizing a printing press.

12. The process for incorporating at least one electronic element in the manufacture of a plastic card as recited in claim 1, wherein a coating step is carried out on at least one surface of said core utilizing a coating technique selected from the group consisting of silk screen printing, offset printing, letterpress printing, screen printing, roller coating, spray printing, and litho-printing.

13. The process for incorporating at least one electronic element in the manufacture of a plastic card as recited in claim 1, having a further step after said step (c) comprising:

(a) positioning an overlaminate film on said at least one surface of said core;

(b) subjecting said core to a heat and pressure cycle comprising the steps of:

(i) heating said core to a temperature between approximately 175° F. to 300° F. for approximately 10 to 25 minutes;

(ii) applying approximately 1000 p.s.i. pressure to said core; and

(iii) cooling said core to a temperature in the range of approximately 40° F. to 65° F. for approximately 10 to 25 minutes.

14. The process of claim 13, further comprising the step of coating said at least one surface of said core with a layer of ink prior to positioning said overlaminate film on said at least one surface of said core.

15. A process as recited in claim 1 comprising the further step of inserting a second electronic element into said cavity, the second electronic element being in electrical communication with the at least one electronic element.

16. The process for incorporating at least one electronic element in the manufacture of a plastic card as recited in claim 1, wherein said at least one electronic element is a micro-chip and an associated circuit board antenna or an associated wire antenna.

17. The process for incorporating at least one electronic element in the manufacture of a plastic card as recited in claim 1, wherein said at least one electronic element is a read/write integrated chip and an associated antenna.

18. The process according to claim 1, wherein the pressure on said core in step (c)(i) is less than 10 p.s.i.

19. The process according to claim 1, wherein said core is heated in step (c)(ii).

20. A process for incorporating at least one electronic element in the manufacture of a plastic card, comprising the steps of:

(a) providing first and second plastic core sheets;

(b) positioning said at least one electronic element in the absence of a non-electronic carrier directly between said first and second plastic core sheets to form a core, said plastic core sheets defining a pair of inner and outer surfaces of said core;

(c) positioning said core in a laminator apparatus, and subjecting said core to a heat and pressure cycle, said heat and pressure cycle comprising the steps of:

(i) heating said core for a first period of time;

(ii) applying a first pressure to said core for a second period of time such that said at least one electronic element is encapsulated by said core:

(iii) cooling said core while applying a second pressure to said core, the second pressure being at least 10% greater than the first pressure.

21. The process according to claims 20, further comprising:

forming a cavity in said core.

22. The process according to claim 21, wherein the step of forming a cavity in said core comprises:

after step (c), milling a region of said core to a controlled depth so as to form a cavity which exposes at least one contact pad of said at least one electronic element.

23. The process according to claim 22, further comprising:

inserting a second electronic element into said cavity, the second electronic element being in electrical communication with the at least one electronic element.

* * * * *

(19) Japan Patent Office (JP)

(12) **Japanese Unexamined Patent Application Publication** (A)

(11) Japanese Unexamined Patent Application Publication Number
H6-176214

(43) Publication date: June 24, 1994

(51) Int. Cl.[5]		Identification symbols		FI		
G 06 K	19/07					
B 42 D	15/10	521	9111-2C			
G 06 K	19/077					
			8623-5L	G 06 K	19/00	H
			8623-5L			K

Request for examination: Not yet submitted Number of inventions: 1 (Total of 3 pages)

(21) Japanese Patent Application H4-330574

(22) Date of Application December 10, 1992

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(54) (Title of the Invention)
THIN NON-CONTACT IC CARD

(57) (Abstract)
(Objective) To offer a thin non-contact IC card that houses an IC module and a coil for reception or transmission that connects to the IC module and receives or transmits signals without being in contact with an external device, where the thickness is decreased to produce a thin card, and by this means, portability is improved, while also improving strength with respect to bending or impact.
(Constitution) A thin IC module and a thin transmission/receiving coil are planarly disposed without overlapping, plastic film is interposed between both surfaces of the thin IC modules and thin transmission/receiving coil, and in addition, both surfaces are sandwiched with a plastic surface material, whereupon heating and compression are performed to effect fixation and integration.
(Effect) By producing a thin card shape with reduced thickness, portability is improved and strength with respect to bending and impact are improved. In addition, the thin IC module and the thin transmission/receiving coil are reliably shielded from external parts so that damage to the thin IC module and thin transmission/receiving coil due to ingress of water can be prevented.

[see source for figure]

(Scope of Patent Claims)
(Claim 1) A thin non-contact IC card that houses a thin IC module and a thin transmission/receiving coil that is connected to said thin IC module and performs transmission and receiving of signals without being in contact with an external device, said non-contact IC card characterized in that said thin IC module and thin transmission/receiving coil are planarly disposed so as to not overlap, plastic film is interposed on both surfaces of the thin IC module and thin transmission/receiving coil, both surfaces are sandwiched by a plastic surface material, and heating and compression are carried out to effect fixation and integration.
(Detailed description of the invention)
(0001)
(Field of industrial application) The present invention relates to a non-contact IC card that houses an IC module and a transmission/receiving coil that is connected to the IC module and transmits and receives signals without being in contact with an external device. In particular, the present invention relates to at thin non-contact IC card whereby portability is improved and strength with respect to bending and impact are improved by producing a thin card with reduced thickness.
(0002)
(Prior art) In the past, non-contact IC cards that house an IC module and transmission receiving coil that is connected to the aforementioned IC module and transmits and receives signals without being in contact with an external device, as shown in the oblique view of Figure 4, have been produced by housing an IC module X and a transmission/receiving coil Y in a housing Z comprising a plastic box Z1 and a lid Z2 and then adhering the box Z1 and lid Z2 together, or by disposing the IC module X and transmission/receiving coil Y in a mold, and then injection molding plastic to integrate them.
(0003)
(Problems to be solved by the invention) With the aforementioned conventional non-contact IC cards, the card is housed in a housing Z comprising a plastic box Z1 and lid Z2, where the box Z1 and lid Z2 are bonded. If the box Z1 and lid Z2 are not adhered together sufficiently well, then water can enter therein from the sites of adhesion, and may damage the IC module X and transmission/receiving coil Y. In addition, the unit is thick at about 10 mm. Moreover, an IC module X and transmission/receiving coil Y are disposed in a mold and plastic is injection molded in order to perform integration. Consequently, labor is required in order to place the IC module X and transmission/receiving coil Y in the mold. In addition, when a thick unit is formed in the form of a flat plate by injection molding, problems such as curving occur, and a unit with the desired external appearance cannot be obtained.
(0004)
(Means for solving the problems) The present invention solves the above problems, and the gist thereof relates to a thin non-contact IC card which houses a thin IC module and a thin transmission/receiving coil that is connected to said thin IC module and performs transmission and receiving of a signal without contacting an external device, where the aforementioned thin IC module and thin transmission/receiving coil are planarly disposed without overlapping, a plastic film is interposed on both surfaces of the thin IC module and the thin transmission/receiving coil, and the components are sandwiched on both surfaces with a plastic surface material. By heating and compressing the unit, the components are fixed and integrated, thus producing a thin card-shaped unit. As a result, portability is improved and strength with respect to bending and impact is improved. The thin IC module and thin transmission/receiving coil are also reliably shielded from the outside, so that damage to the thin IC module and transmission/receiving coil due to the ingress of water is prevented.
(0005)
(Embodiments) Working examples of the present invention are described in detail below based on the figures. Figure 1 is a plan view of the thin non-contact IC card of the present invention. Figure 2 is a cross-sectional view of the main elements of the thin non-contact IC card of the present invention. Figure 3 is a side cross-sectional view showing the condition in which the thin non-contact IC card of the present invention is manufactured.
(0006) As shown in the plan view of Figure 1, the external dimensions of the thin non-contact IC card 10 comprise a transverse dimension of about 86 mm, a longitudinal dimension of about 54 mm and a thickness of about 1 mm. The thin non-contact IC card 10 has a thin IC module 11 that houses components such as an IC memory (not shown in figure) and a rectification circuit (not shown in figure) and a transmission/receiving coil 12 that is connected with the aforementioned thin IC module 11. 13 denotes an embossed region, and is formed separated from the location at which the thin IC module 11 is housed and the location at which the thin transmission receiving coil 12 is housed. By forming the embossed region 13 separated from the location where the thin IC module 11 is housed and the location at which the thin transmission receiving coil 12 is housed in this manner, there is little influence on the thin IC module 11 or thin transmission/receiving coil 12 when the embossed region 13 is subjected to the embossing process, which is desirable. As presented in the cross-sectional view of Figure 2, the thickness T1 of the thin IC module 11 is about 0.3 mm. The thin transmission receiving coil 12 has copper conductor 12b with a diameter of about 0.1 mm wound on a flat ferrite core

12a with a thickness T2 of about 0.4 mm, so that the thickness T3 thereof is about 0.5 mm. The thin transmission/receiving coil 12, by means of electromagnetic coupling with an external device or by means of electromagnetic induction, can send and receive information stored in the thin IC module 11 without being in contact with an external device. By means of the rectifying circuit that is provided in the thin IC module 11, the AC current that is induced in the thin transmission/receiving coil 12 is rectified, and serves as a power source for the thin IC module 11. For this reason, a separate power source need not be housed therein.

(0007) 14 and 14 denote polyvinyl chloride resin plastic films with thicknesses of about 0.1 mm, where the films are interposed so that they sandwich the thin IC module 11 and thin transmission/receiving coil 12 from both surfaces of the thin IC module 11 and thin transmission/receiving coil 12. In addition, both surfaces of the plastic films 14, 14 such as polyvinyl chloride resin with a thickness of about 0.3 mm are sandwiched with plastic surface material 15, 15 comprising a material such as polyvinyl chloride resin, and by heating and compression, the unit is integrated to produce a thickness of about 1 mm.

(0008) In manufacture of the thin non-contact IC card 10 of the present invention, the thin IC module 11 and thin transmission/receiving coil 12 are disposed so that they do not overlap as shown in the side cross-sectional view of Figure 3, plastic films 14 and 14 comprising polyvinyl chloride resin or other such material with a thickness of about 0.1 mm is interposed on both surfaces of the thin IC module 11 and thin transmission/receiving coil 12, and after sandwiching both surfaces with a plastic surface material 15 and 15 comprising polyvinyl chloride resin or other such material with a thickness of about 0.3 mm, heating and compression are applied from both surfaces with hot plates 20 and 20, thereby fixing and integrating the elements.

(0009)

(Effect of the invention) As stated above, by means of the present invention, a thin IC module and a thin transmission/receiving coil are planarly disposed without overlapping, a plastic film is interposed on both surfaces of the thin IC module and thin transmission/receiving coil, and in addition, both surfaces are sandwiched with a plastic surface material. By then applying heat and compression to fix and integrate the unit, the thickness is reduced in order to form a thin card-form unit. By this means, portability is improved and strength with respect to bending and impact is improved. There is also the disadvantage that it is possible to prevent damage to the thin IC module and thin transmission/receiving coil by the ingress of water, because the thin IC module and thin transmission/receiving coil are reliably shielded from the outside.

(Brief description of the drawings)

(Figure 1) Plan view showing the thin non-contact IC card of the present invention.

(Figure 2) Cross sectional view showing the essential components of the thin non-contact IC card of the present invention.

(Figure 3) Side cross-sectional view showing the condition of manufacture of the thin non-contact IC card of the present invention.

(Figure 4) Oblique view showing a conventional non-contact IC card.

10	Thin non-contact IC card
11	Thin IC module
12	Thin transmission/receiving coil
13	Embossed region
14	Plastic film
15	Plastic surface material

[see source for figures]

(Figure 1)

(Figure 2)

(Figure 3)

(Figure 4)

(19)日本国特許庁（JP） (12)公開特許公報(A) (11)特許出願公開番号

特開平6－176214

(43)公開日 平成6年(1994)6月24日

(51) Int. Cl.⁵	識別記号		F I	
G06K 19/07				
B42D 15/10	521	9111-2C		
G06K 19/077				
		8623-5L	G06K 19/00	H
		8623-5L		K

審査請求 未請求 請求項の数1 （全3頁）

(21)出願番号 特願平4－330574

(22)出願日 平成4年(1992)12月10日

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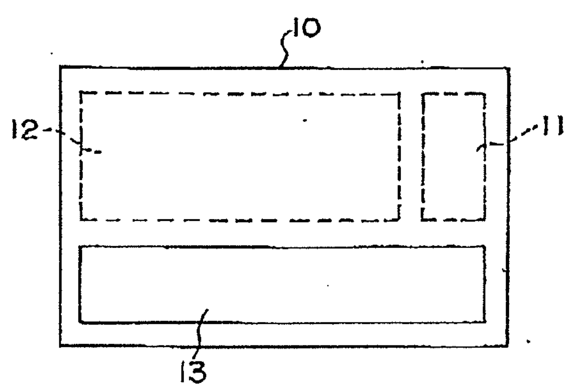
(54)【発明の名称】薄型非接触ICカード

(57)【要約】

【目的】 ICモジュールと、ICモジュールに接続され外部装置と非接触で信号の受発信を行う受発信用コイルを内蔵した非接触ICカードであって、厚みを薄くして薄型のカード状とすることにより、携帯性を向上させると共に、曲げ、衝撃に対する強度を向上させた薄型非接触ICカードカードを提供する。

【構成】 薄型ICモジュールおよび薄型受発信用コイルを重ね合わせることなく平面配置すると共に、薄型ICモジュールおよび薄型受発信用コイルの両面にプラスチック製フィルムを介在させ、さらに両面からプラスチック製表面材で挟持して、加熱圧着して固着一体化した薄型非接触ICカード。

【効果】 厚みを薄くして薄型のカード状とすることにより、携帯性を向上させると共に、曲げ、衝撃に対し強度を向上させ、薄型ICモジュールおよび薄型受発信用コイルを外部から確実に遮蔽して、外部から水が侵入して薄型ICモジュールおよび薄型受発信用コイルが破損するのを防止することができる。



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【特許請求の範囲】

【請求項1】薄型ICモジュールと、該薄型ICモジュールに接続され外部装置と非接触で信号の受発信を行う薄型受発信用コイルを内蔵した薄型非接触ICカードであって、前記薄型ICモジュールおよび薄型受発信用コイルを重ね合わせることなく平面配置すると共に、薄型ICモジュールおよび薄型受発信用コイルの両面にプラスチック製フィルムを介在させ、さらに両面からプラスチック製表面材で挟持して、加熱圧着して固着一体化したことを特徴とする非接触ICカード。

【発明の詳細な説明】

【0001】

【産業上の利用分野】本発明は、ICモジュールと、ICモジュールに接続され外部装置と非接触で信号の受発信を行う受発信用コイルを内蔵した非接触ICカードに関し、とくに厚みを薄くして薄型のカード状とすることにより、携帯性を向上させると共に、曲げ、衝撃に対する強度を向上させた薄型非接触ICカードに関する。

【0002】

【従来の技術】従来、ICモジュールと該ICモジュールに接続され外部装置と非接触で信号の受発信を行う受発信用コイルを内蔵した非接触ICカードとしては、図4に斜視図で示すように、ICモジュールXと受発信用コイルYとを、プラスチック製の箱体Z1と蓋体Z2とからなる匡体Z内に収納し、箱体Z1と蓋体Z2とを接着したもの、あるいはICモジュールXと受発信用コイルYとを金型内に配置し、プラスチックを射出成形して一体化するものが知られている。

【0003】

【発明が解決しようとする課題】上記従来の非接触ICカードでは、プラスチック製の箱体Z1と蓋体Z2とからなる匡体Z内に収納し、箱体Z1と蓋体Z2とを接着するものにおいては、箱体Z1と蓋体Z2との接着が十分でないと、接着箇所から水が内部に侵入し、ICモジュールXと受発信用コイルYが破損するおそれがあり、また、厚みも約10mmと厚いものであった。また、ICモジュールXと受発信用コイルYとを金型内に配置し、プラスチックを射出成形して一体化するものにあっては、金型内にICモジュールXと受発信用コイルYとを配置するのに手間がかかるばかりか、射出成形により、平板状で、厚みが薄いものを成形すると、反りが生じ、外観上好ましいものが得られない等の問題点があった。

【0004】

【課題を解決するための手段】本発明は、上記課題を解決するものであって、その要旨は、薄型ICモジュールと、該薄型ICモジュールに接続され外部装置と非接触で信号の受発信を行う薄型受発信用コイルを内蔵した薄型非接触ICカードであって、前記薄型ICモジュールおよび薄型受発信用コイルを重ね合わせることなく平面

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配置すると共に、薄型ICモジュールおよび薄型受発信用コイルの両面にプラスチック製フィルムを介在させ、さらに両面からプラスチック製表面材で挟持して、加熱圧着して固着一体化することにより、厚みを薄くして薄型のカード状とすることにより、携帯性を向上させると共に、曲げ、衝撃に対し強度を向上させ、薄型ICモジュールおよび薄型受発信用コイルを外部から確実に遮蔽して、外部から水が侵入して薄型ICモジュールおよび薄型受発信用コイルが破損するのを防止した薄型非接触ICカードである。

【0005】

【実施例】以下、本発明の実施例を図面に基づき具体的に説明する。図1は本発明の薄型非接触ICカードを示す平面図、図2は本発明の薄型非接触ICカードの要部を示す断面図、図3は本発明の薄型非接触ICカードを製造する状態を示す側断面図である。

【0006】図1に平面図で示すように、薄型非接触ICカード10の外径寸法は、横寸法が約86mm、縦寸法が約54mmであり、厚みは約1mmである。薄型非接触ICカード10には、ICメモリ（図示略）と整流回路等（図示略）を内蔵した薄型ICモジュール11と、該薄型ICモジュール11に接続された薄型受発信用コイル12を内蔵している。13はエンボス領域であって、薄型ICモジュール11が内蔵された位置と薄型受発信用コイル12が内蔵された位置を避けて形成してある。このように、エンボス領域13を、薄型ICモジュール11が内蔵された位置と薄型受発信用コイル12が内蔵された位置を避けて形成すると、エンボス領域13にエンボス加工をしても、薄型ICモジュール11および薄型受発信用コイル12に影響が少ないので、好適である。図2に断面図で示すように、薄型ICモジュール11の厚みT1は、約0．3mmとしてある。薄型受発信用コイル12は、厚さT2が約0．4mmの平板状フェライトコア12aに、直径が約0．1mmの銅線12bを巻き付け、その厚さT3は約0．5mmとしてある。薄型受発信用コイル12は、外部装置と電磁結合または電磁誘導により、薄型ICモジュール11に記憶される情報を外部装置と非接触で受発信する。薄型ICモジュール11に設けられた整流回路により、薄型受発信用コイル12に励起された交流電流を整流して薄型ICモジュール11の電源とされる。このため、電池を別途内蔵する必要はない。

【0007】14、14は厚みが約0．1mmのポリ塩化ビニル樹脂製等のプラスチック製フィルムであって、薄型ICモジュール11および薄型受発信用コイル12の両面から、これら薄型ICモジュール11および薄型受発信用コイル12を狭持するようにして介在させてあると共に、厚みが約0．3mmのポリ塩化ビニル樹脂製等のプラスチック製フィルム14、14の両面からポリ塩化ビニル樹脂製等のプラスチック製表面材15、15

で挟持して、加熱圧着して固着一体化し、厚みが約１mmとしてある。

【０００８】本発明の薄型非接触ＩＣカード１０を製造するには、図３に側断面図で示すように、薄型ＩＣモジュール１１と薄型受発信用コイル１２とが重ね合わないようにして配置し、薄型ＩＣモジュール１１および薄型受発信用コイル１２の両面に厚みが約０．１mmのポリ塩化ビニル樹脂製等のプラスチック製フィルム１４、１４を介在させ、さらに両面から厚みが約０．３mmのポリ塩化ビニル樹脂製等のプラスチック製表面材１５、１５で挟持した後、両面から熱板２０、２０で加熱圧着して固着一体化すれば良い。

【０００９】

【発明の効果】以上の通り、本発明によれば、薄型ＩＣモジュールおよび薄型受発信用コイルを重ね合わせることなく平面配置すると共に、薄型ＩＣモジュールおよび薄型受発信用コイルの両面にプラスチック製フィルムを介在させ、さらに両面からプラスチック製表面材で挟持して、加熱圧着して固着一体化することにより，厚みを薄くして薄型のカード状とすることにより、携帯性を向上させると共に、曲げ、衝撃に対し強度を向上させ、薄型ＩＣモジュールおよび薄型受発信用コイルを外部から確実に遮蔽して、外部から水が侵入して薄型ＩＣモジュールおよび薄型受発信用コイルが破損するのを防止することができるなどの利点がある。

【図面の簡単な説明】

【図１】本発明の薄型非接触ＩＣカードを示す平面図

【図２】本発明の薄型非接触ＩＣカードの要部を示す断面図

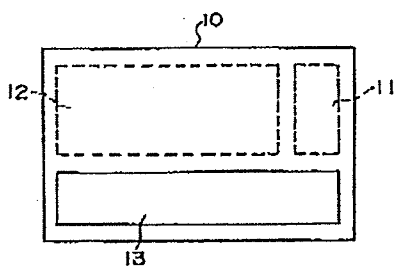
【図３】本発明の薄型非接触ＩＣカードを製造する状態を示す側断面図

【図４】従来の非接触ＩＣカードを示す斜視図

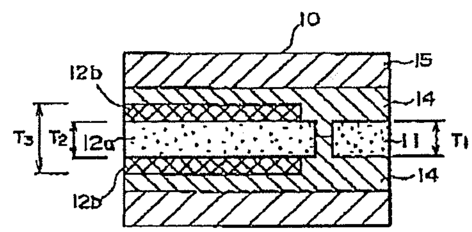
【符号の説明】

１０　薄型非接触ＩＣカード
１１　薄型ＩＣモジュール
１２　薄型受発信用コイル
１３　エンボス領域
１４　プラスチック製フィルム
１５　プラスチック製表面材

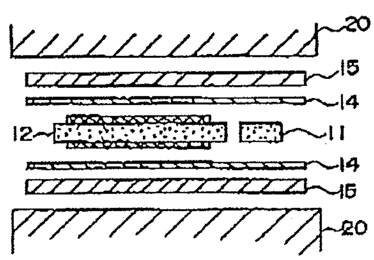
【図１】



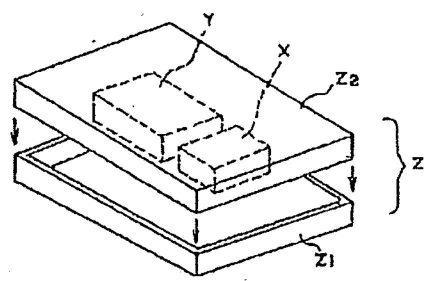
【図２】



【図３】



【図４】



US005399223A

United States Patent [19]

Vogt

[11] Patent Number: 5,399,223

[45] Date of Patent: Mar. 21, 1995

[54] **METHOD AND DEVICE FOR LAMINATING LAYERS OF IDENTIFICATION CARDS, OR THE LIKE**

[75] Inventor: **Werner Vogt**, Remetschwil, Switzerland

[73] Assignee: **Interlock AG**, Schlieren, Switzerland

[21] Appl. No.: **992,940**

[22] Filed: **Dec. 18, 1992**

[30] **Foreign Application Priority Data**

Dec. 19, 1991 [DE] Germany 41 41 972.3
Dec. 15, 1992 [DE] Germany 42 42 210.8

[51] **Int. Cl.**[6] **B29C 65/00**
[52] **U.S. Cl.** **156/285; 156/311; 156/498; 156/583.1**
[58] **Field of Search** .... 156/285, 286, 311, 312, 156/498, 583.1; 264/327; 100/38, 93 P; 425/407

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4,752,204	6/1988	Kataoka	425/384

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Primary Examiner—David A. Simmons
Assistant Examiner—J. Sells
Attorney, Agent, or Firm—Darby & Darby

[57] **ABSTRACT**

For laminating layers consisting at least in part of thermoplastic films, in particular for producing identification cards, or the like, carrying information and/or data, a method is proposed where the blank, after having been introduced between pressing dies, is initially subjected to the pressure and heat required for complete lamination of the blank. Heat dissipation is prevented during heating by the fact that cooling components are kept at a predetermined distance from the heating surfaces. During a subsequent transition from heating to cooling, the heating effect is terminated and cooling bodies are brought into contact with the pressing and heating components, for reducing the temperature of the completely laminated product.

10 Claims, 5 Drawing Sheets

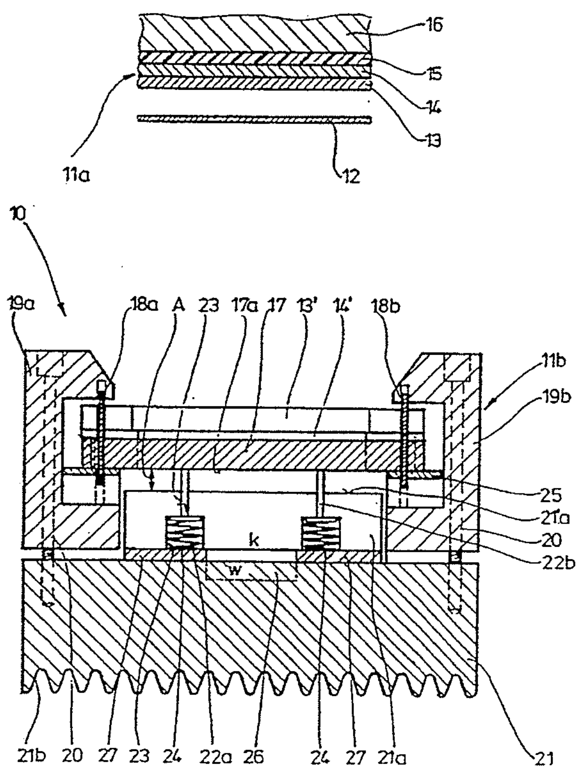


Fig.1

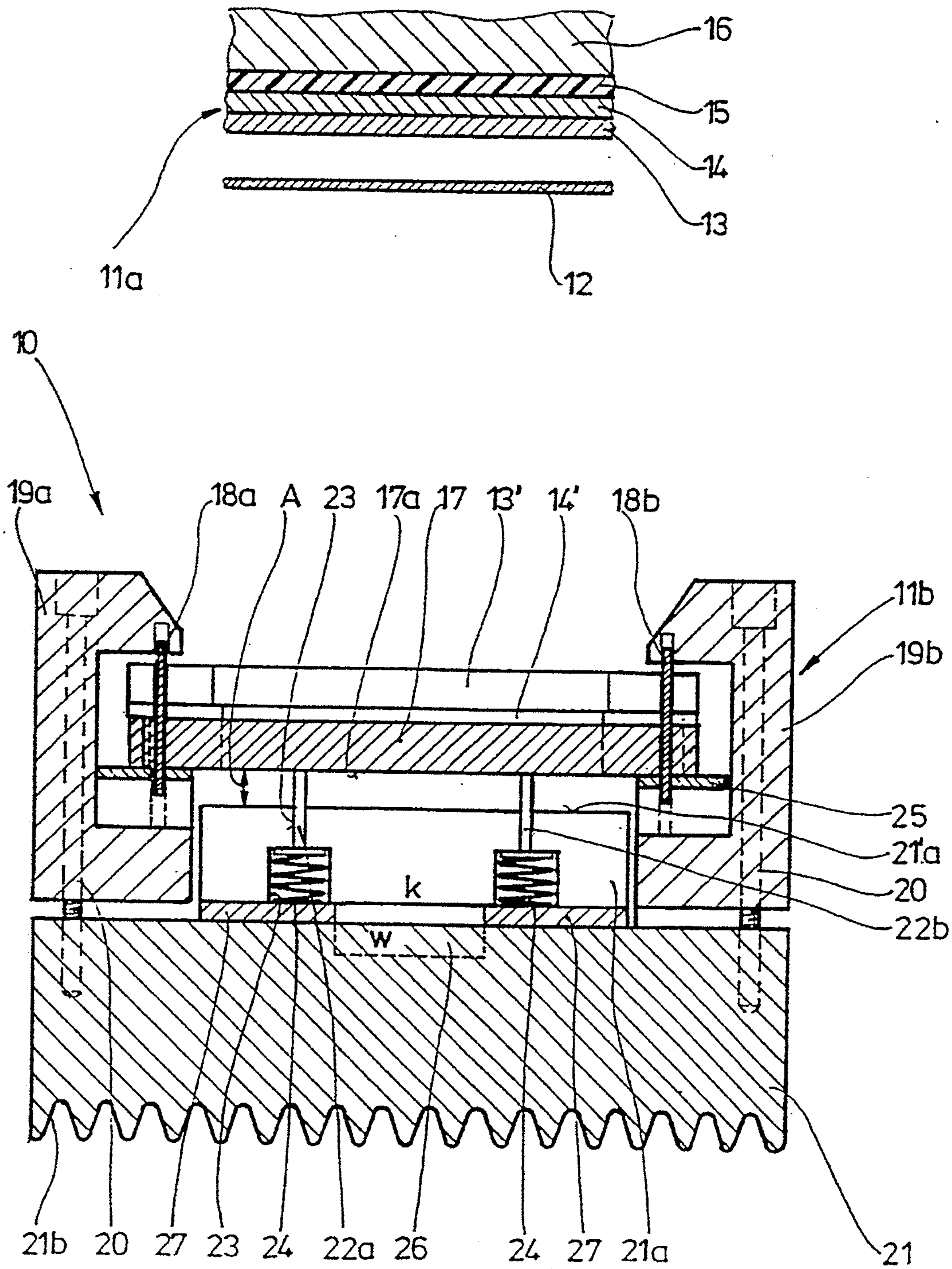

16
15
14
13
11a
12
10
19a
18a
A
23
17a
17
13'
14'
18b
11b
19b
25
21a
20
22b
k
w
21b
20
27
23
24
22a
26
24
27
21a
21

Fig. 2

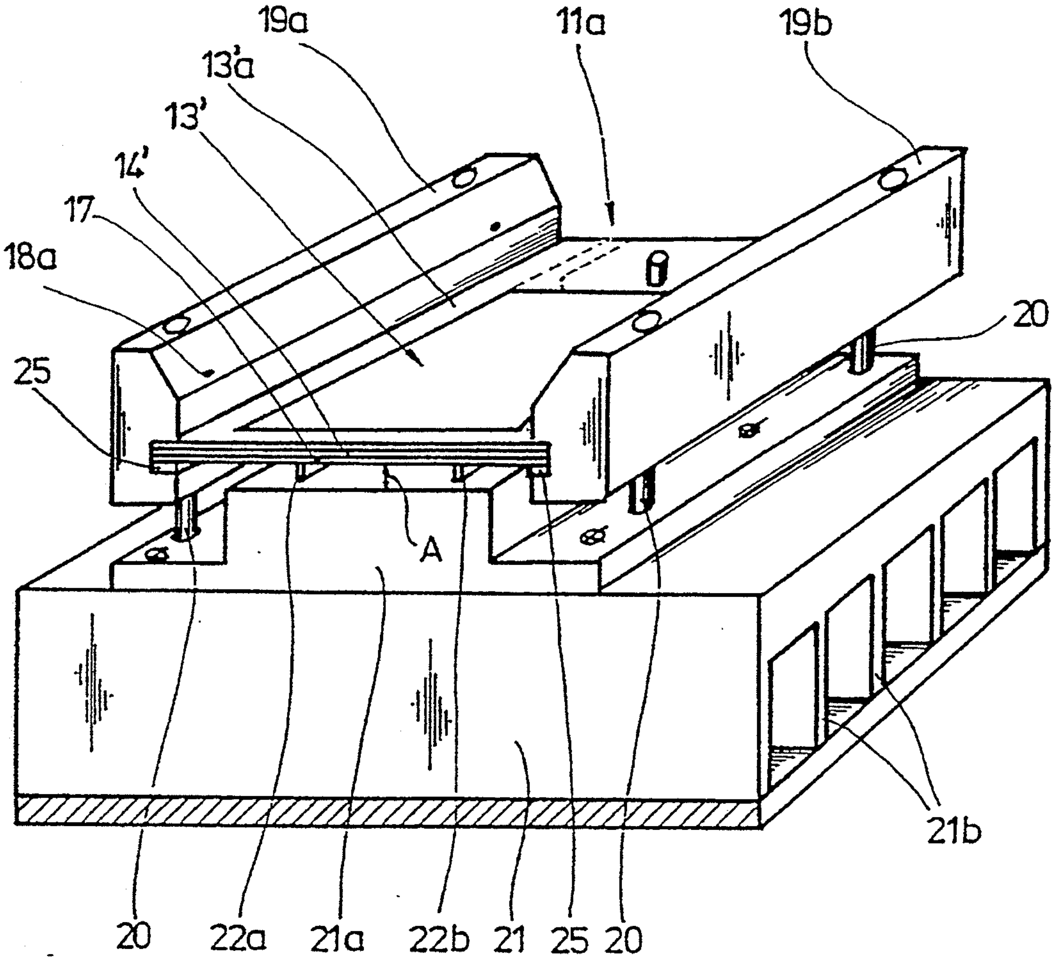


Fig. 3

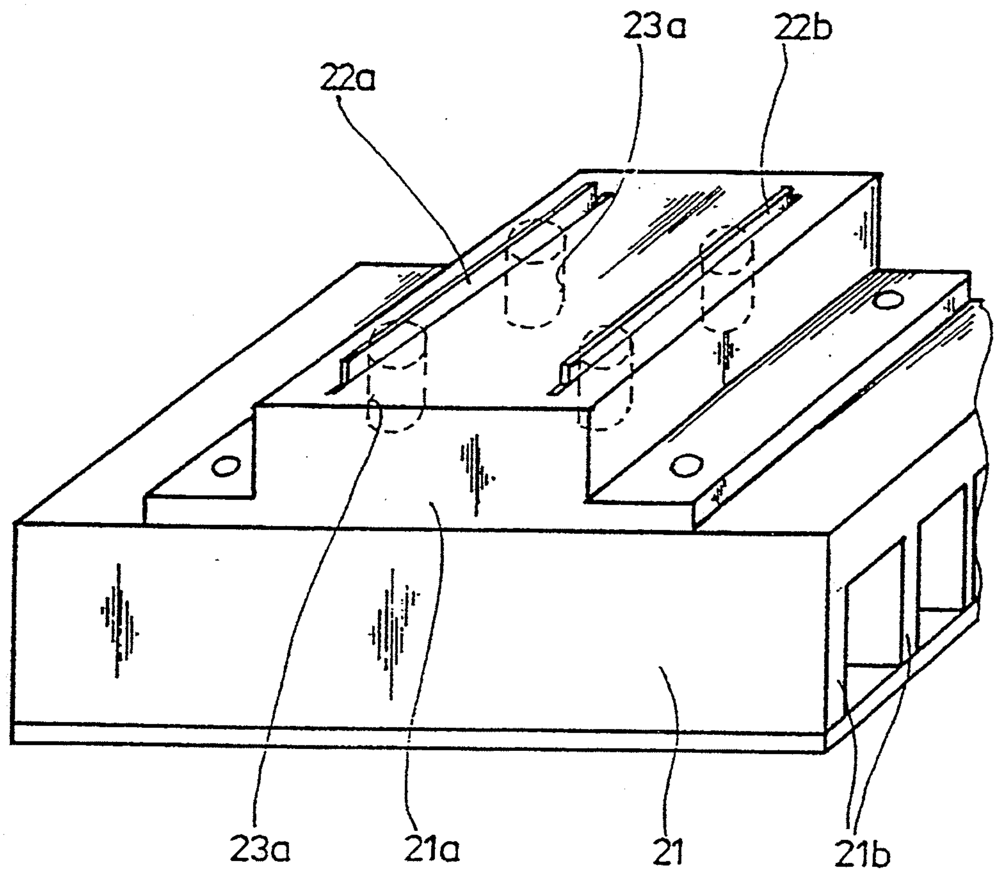


Fig.4

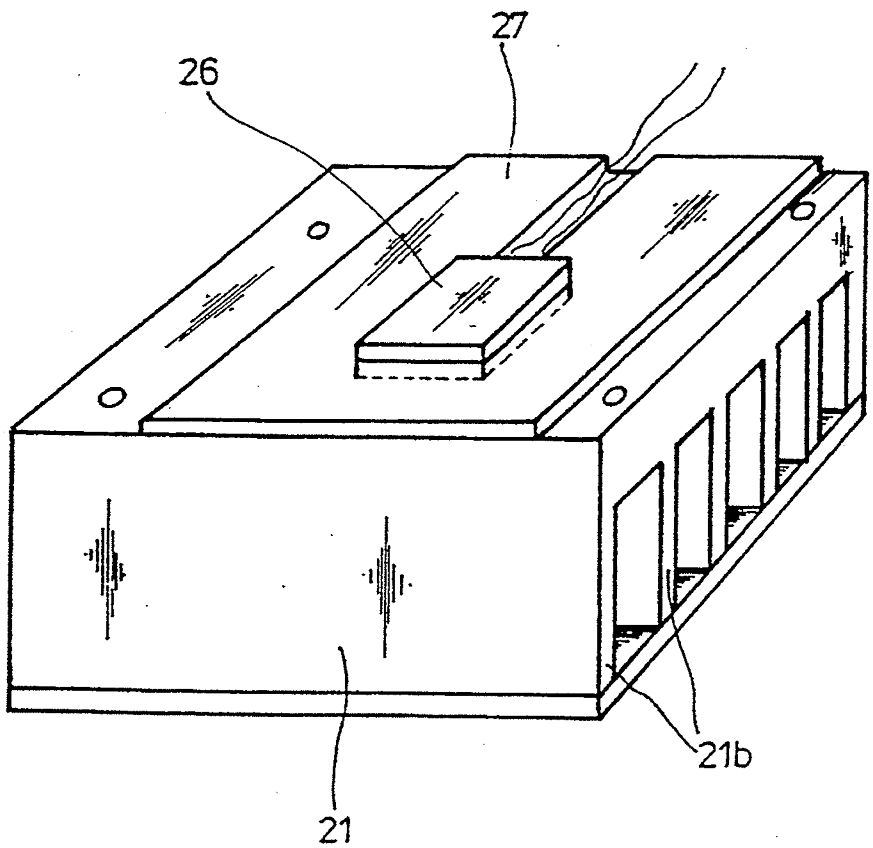
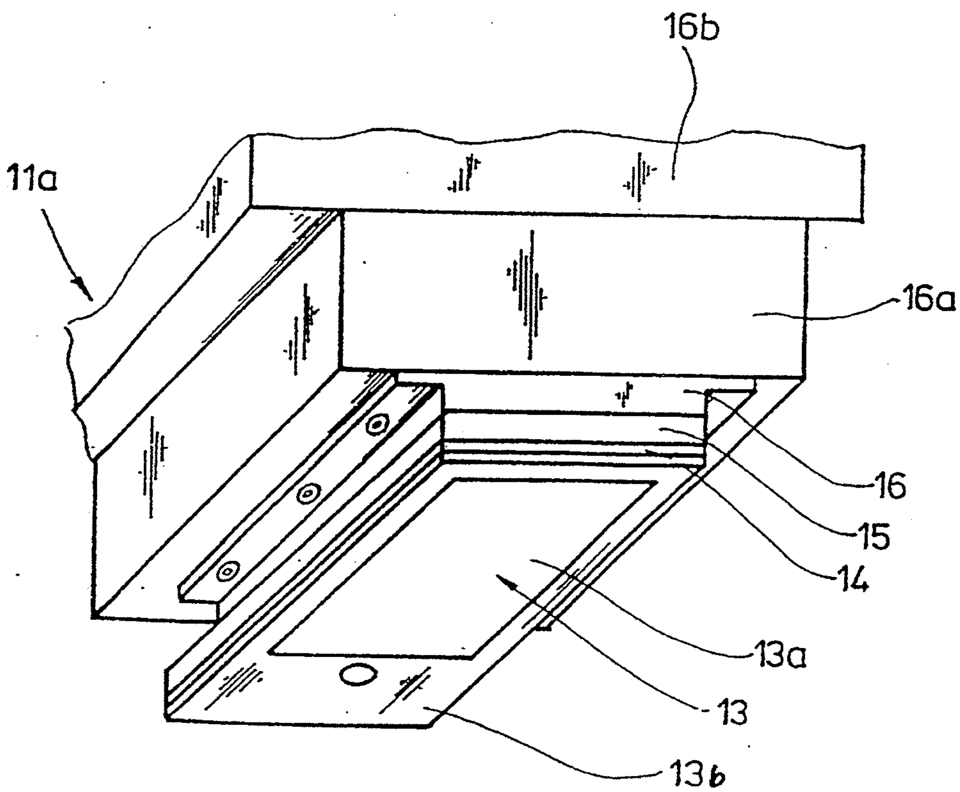


Fig.5



METHOD AND DEVICE FOR LAMINATING LAYERS OF IDENTIFICATION CARDS, OR THE LIKE

BACKGROUND OF THE INVENTION

The present invention relates to a method for laminating layers consisting at least in part of thermoplastic films.

In the case of known methods for laminating layers, and a corresponding double-plate pressing device for carrying out the method (European Patent Application No. 0013557), the layers are compressed to a composite material under the effect of heat and pressure. This is achieved by initially placing the blank, which is composed of the different layers, in the pressing device and applying two heatable plates on the two sides of the blank so as to exert heat and pressure upon both sides of the blank, and switching off the heating thereafter so that after cooling down the identification cards so produced can be removed from the pressing device.

In addition to disclosing the arrangement of resistance wires in the oversized pressing plates arranged on both sides, which interact directly with the layers to be laminated and which are screened from the supporting plates of the pressing device on which they are mounted by interposed insulating layers, this publication also discloses an arrangement where the pressing plates are configured as cooled supporting plates and are preceded by a flat heating resistance layer serving as a heating element, the heating resistance layer being arranged so as to directly face the layers to be laminated and being thermally screened against the cooled supporting plates by an insulating layer. The heating resistance layer is supplied with pulse-shaped voltages from a heater voltage source, it being an additional particularity of this known laminating device that certain, especially heat-sensitive security features, such as guilloche prints or watermarks, microfilm formers, holograms, or the like, can be provided in the check, identity or passport cards by means of dies arranged exclusively in the area of these additional pressure and temperature sensitive security features, which dies are set off to the rear and have a temperature lower than the temperature of the plates producing the heating effect. Consequently, the pressure in the area of the die openings is lower than the lamination pressure, and the temperature is also lower in these areas than the temperature of the plate.

The problem with all the laminating devices of the prior art lies in the fact that the production cycle consists of two clearly distinguishable subcycles, namely the initial application of heat, which should be as abrupt as possible to attain the laminating temperature of the layers of the identification card—only this term will be used hereafter to describe the object to be produced—that are to be fused, and a subsequent cooling cycle which is initiated by switching off the heating elements and during which the pressing device may not be opened to remove the laminated card blank because the latter still lacks the necessary mechanical stability.

It is, therefore, desirable to subject the blank, or initially the composite layers, in the pressing device at first to a heating step and then to a cooling phase, which means that the insulating layer arranged between the flat film heating layer and the pressing plate, which latter is actively cooled in most of the cases, has to fulfill two opposing functions both of which are performed by

it unsatisfactorily: During the heating phase, it is to protect the adjacent cooling plates as perfectly as possible from the heat emitted or applied by the heating element, and to direct such heat to the layers to be laminated, while during the cooling phase, after the heating has been switched off, the heat flow, which previously was to be suppressed, is now to be enabled perfectly and comprehensively, and exactly in the direction toward the cooled supporting plates, i.e. that direction in which no heat flow was allowed during the preceding heating phase.

If, therefore, the "insulating layer" is designed to provide a highly heat-insulating effect, a good heating effect but unsatisfactory recooling is obtained, whereas the selection of a highly heat-conducting material for the "insulating layer" leads to satisfactory recooling, but impairs the initially required heat insulation.

The laminating device for producing identification cards known from European Patent Specification No. 0 154 970 also recognizes this problem mentioning that theretofore such laminating devices consisted of a heating element formed by glass fiber mats, arranged directly adjacent a metal block comprising heating fins, with resistance ladder paths arranged between the glass fiber mats. Thus, a considerable share of the heat initially produced flows into the metal block, thereby heating the latter, and cooling can be effected only after fusing of the card blanks, as otherwise the necessary fusing temperature will not be reached during the fusing process. Recooling of the heated mass of the metal block must take place only after completion of the fusing process. All this shows that with the cooling devices previously known the different phases of the before-mentioned cycles do not function properly, and that one therefore tries to make the disadvantages, which are always encountered, controllable by the use of a specifically designed time control. Yet, it cannot be avoided that a comparatively long total cycle (heating up and subsequent recooling) has to be accepted. In practice, such a cycle always takes between half of a minute and several minutes, and the heat losses are still very considerable, although the cited Patent Specification 0154 970 speaks, however, of a few seconds only.

Another publication describing a further known device (U.S. Pat. No. 4,108,713), which is also suited for laminating identification cards, provides a more detailed description of the flat heating element normally used for the lamination process. The heating element consists in this case of a carrier plate of small mass and correspondingly low thermal capacity so that both the heating process and the subsequent recooling process can be effected very quickly; the metallic carrier plate has a thickness of less than 0.25 mm, and an electric insulating layer consisting of silicone rubber is arranged between the flat heating element proper and the carrier plate. The flat heating element comprises flat resistance wires arranged in a meandering pattern, and a heat sensor is provided adjacent the resistance wires for heat control purposes.

In a different context, i.e. in connection with the production of thin thermoplastic synthetic resin films, a process is known (U.S. Pat. No. 4,752,204) where a resin block blank consisting of the respective synthetic resin is heated between a pair of heated pressing plates, while its dimensions are considerably changed under the effect of pressure in order to deform it into a film.

For this purpose, a suitable pressing tool consists of two oppositely arranged pressing jaws with pressing plates provided therein on both sides which pressing plates are held, under the effect of springs, at a certain distance from adjoining cooling blocks and are intended for receiving the synthetic resin block between them.

As one realized that it is not possible to cool and heat simultaneously, one decided in the case the pressing surfaces, which are kept at a distance from the cooling blocks, to first introduce between the surfaces a heating element, from a different location, for heating up the pressing surfaces on both sides. As soon as the surfaces are heated up sufficiently—the heat being initially prevented from dissipating through the existing spacing to the adjoining cooling blocks—the heating element is withdrawn, and the synthetic resin block to be deformed is inserted. Thereafter, the pressing dies are moved toward each other, and the heated pressing surfaces are pressed simultaneously against the cooling plates and the inserted synthetic resin block, while the previously active biasing springs give way, so that during the deforming process—and this is the only decisive aspect—the heat introduced is simultaneously transmitted to the blank and dissipated via the cooling blocks. Such a process may be suited for the production of films from thermoplastic synthetic resins, but is of no use for the production of a laminated composite material for identification cards, or the like, because it does not in any way remedy the real problem, namely that the heat is simultaneously introduced and dissipated during the processing step, i.e. when heat and pressure are exerted on the blank.

Another known method, which similarly belongs to a different class and which is intended for producing sandwich panels, makes use of intermediate products consisting of high-performance composite materials with polymeric matrices (German Offenlegungsschrift 39 10 021). Such sandwich elements comprise an inner honeycomb material, consisting for example of aluminium, a plastic material or impregnated paper, with polymers applied thereon as top laminates. The precut intermediate product, consisting of polymeric top layers and the core material, is initially heated up between two plates by resistance heating in pressureless condition, the pressure initially applied upon the two heating plates on both sides, via pressure springs and insulators, being just sufficient to ensure satisfactory heat transfer from the heating plates to the intermediate product.

Only when the processing temperature has been reached will the outer cooled pressing plates move toward the heating plates on both sides, and the heated intermediate product between them, so that during this phase the core material is compressed and united with the heated-up top layers, while heat is simultaneously dissipated from the heating plates toward the cooled die plates. It has to be assumed in this case that in practice the cooling action necessarily must be initiated before applying the pressing force required for the deformation process, as the pressing force can be applied only after the cooled pressing plates are in full contact with the extremely thin heating plates. This means that in the case of this known method, too, at least cooling and deformation take place simultaneously.

Now, it is the object of the present invention to remedy this situation and to provide a method for producing identification cards, credit cards, and the like, which reconciles and complies with the fundamentally opposing requirements of ensuring at the same time efficient thermal insulation (during the heating process), followed by rapid and perfect, unobstructed cooling of the laminated product.

SUMMARY OF THE INVENTION

The invention clearly subdivides the laminating process physically into a heating phase and a subsequent cooling phase, without any overlapping in time and, as a result thereof, without any mixed behavior that would impair the quality of the product.

The invention, therefore, succeeds on the one hand in carrying out the entire laminating process quickly and, thus, in ensuring an especially high quality of the product, i.e. the identification card, credit card, identity card, or the like, composed of a plurality of laminate layers, and on the other hand in enhancing the thermoplastic behavior of the laminate layers by precise, highly efficient and chronologically distinguished processing steps (heating - cooling).

The heating efficiency is decisively improved due to the fact that practically no heating losses are encountered so that the plasticizing and fusing process starts by a steep temperature rise and terminates after a short dwelling time, while on the other hand the cooling effect is also decisively improved due to the fact that now dissipation of the heat present at the end of the heating subcycle can take place unobstructedly, as a result of a valve effect provided by the components involved in the laminating process, and that in addition a simultaneous controlled cooling action can be produced.

The invention provides the advantage that it is now possible, with only slightly greater mechanical input for at least one of the pressing dies, to attain an extraordinarily good insulating effect during the heating subcycle, which means rapid heating up and a short waiting time until the plasticizing temperature is reached, and subsequently also an especially good heat dissipation effect through direct physical, preferably metallic and highly heat-conducting contact between the direct pressing area for the laminate layers to be laminated, and the cooling bodies. This different treatment within the same pressing and plasticizing zone—different with respect to the heating and cooling subcycles performed in this zone—is rendered possible by the invention due to the fact that a certain relative movement between the components is allowed without the need to apply substantial changes to the pressure-producing mechanisms anyway provided in conventional laminating devices.

This leads to the situation that the pressing and plasticizing zone is differently positioned, depending on the processing cycle (heating - cooling), and this means with respect to the heating and cooling effects exerted on the pressing zone and on the laminate layers positioned therein that the heat applied is prevented, by a highly effective thermal insulation, from being dissipated during the heating subcycle, whereas on the other hand, during the cooling subcycle, heat is virtually extracted from the pressing zone.

According to advantageous embodiment a relative movement between pressing die components is performed only in one of the pressing dies, whereas the other pressing die serves heating functions only and is not subjected to heat dissipation or any cooling action during any of the subcycles, but is instead equipped with thermal insulators so that its heat dissipation varies only as a result of the fact that the heating is switched off during the cooling cycle.

According to another advantageous embodiment, the cooling effect, which is notably activated during the cooling subcycle, is further increased and improved by the combined action of an element which generates a controlled cooling effect, preferably a Peltier element of flat shape. Such an element enables the cooling effect to be enhanced in a particularly efficient way.

According to another advantageous variant of the invention, at least some of the relative movements between the components are effected pneumatically.

For example, the inner area of the die, i.e. the area extending between the two pressing plates and receiving the blank to be laminated, may advantageously be sealed off from the environment and subjected to the action of a vacuum. The correspondingly strong forces so produced are absolutely sufficient to exert the pressing force required for the laminating process during the heating phase. This application of a vacuum has the additional decisive advantage that flaws or other phenomena that may be detrimental to the appearance of the blank, such as entrapped air bubbles, or the like, are safely avoided and that a particularly perfect appearance, and excellent quality, can be achieved especially for high-finish laminates.

The further sequence of motions following the heating phase, during which cooling blocks are moved toward the heated sandwich structure (also on both sides) may also be controlled by the existing vacuum. This can be achieved by extending the vacuum effect also to the area of the cooling block (and providing a corresponding peripheral sealing effect) so that the cooling blocks are moved against the respective sandwich structure.

If desired, this action can be additionally supported by the application of compressed air.

BRIEF DESCRIPTION OF THE DRAWING

Certain embodiments of the invention will now be described in more detail by reference to the drawing in which:

FIG. 1 shows a diagrammatic cross-section through a possible embodiment of the upper and the lower dies of a pressing tool used for laminating purposes;

FIG. 2 shows, for the sake of improved understanding, a perspective view of a preferred structure of a die, for example the lower die;

FIG. 3 shows another perspective view representing a detail of the lower die which illustrates particularly clearly the design of the cooling body with spring-loaded supporting webs;

FIG. 4 shows a variant of the design of the cooling body, preferably for the lower die, with an additional cooling element; and

FIG. 5 shows a possible embodiment of an upper die, likewise in perspective representation.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

It is the underlying idea of the invention to decisively improve and shorten the recooling phase, which is always critical in any laminating process, by creating conditions in the area of the pressing die which did not exist during the preceding heating phase. This has the effect that the thermal energy produced during the heating subcycle is practically restricted on all sides by thermal insulators and directed onto the laminate layers to be laminated, so that an especially high utilization factor is achieved, whereas during the subsequent cooling subcycle optimized heat dissipation is rendered possible by the fact that certain components of at least one of the pressing dies perform a sequence of mechanical movements so as to enable cooling surfaces to be moved directly into the area of the heated pressing zone, and especially a cooling body to be brought into contact with the rear surfaces of the die components facing the laminate layers to be laminated, by bridging a previously existing insulating intermediate space.

In FIGS. 1 to 5, the pressing die is indicated by **10**, an upper die by **11***a*, and a lower die by **11***b*.

The structure of the upper die is comparatively simple in this case, it being understood, however, that the upper die may also have the same design as the one that will be described further below for the lower die **11***b*.

In any case, the upper die of the illustrated embodiment—see also FIG. 5—comprises a, preferably metallic, pressing plate **13** provided directly adjacent the laminate package **12** to be laminated and consisting preferably of a suitable, very hard material, such as hard brass, which may also be tinned/nickel-plated. Arranged next to that pressing plate **13**, which may have a thickness of, for example, 0.3 mm is a flat heating film **14**—of the type normally used also in conventional devices—which may have a thickness of maximally 0.1 mm, for example, it being understood that this numerical value—just as any other numerical values stated herein—is not meant to restrict the invention, but only to illustrate it more clearly.

Finally, there may be arranged behind the heating film **14** a pressure-compensating layer **15** which may consist of any suitable material, preferably a plastic material, and here a polyacrylic layer having a thickness of 0.3 mm, for example.

This pressure-compensating layer may then be followed by several other layers, plates or blocks, which may be useful for incorporating the embodiment according to the invention into an existing laminating device where a predetermined spacing is provided in the die area. Such layers or blocks then serve as compensation layers for the existing spacing, provided however that the pressure-compensating layer **15** (for the laminating process) must be followed immediately by a heat insulating layer **16** which is to ensure that the heat generated by the flat heating film **14** cannot flow off unused in this direction. In any event, no cooling is provided for the area of the upper pressing die **11a** so that the heat insulating layer **16** is followed—via another, preferably also heat-insulated intermediate block **16***a*—by an upper rocker construction **16***b* of the type normally provided in laminating devices. This completes the structure of the upper die.

It can be further seen in the representation of FIG. 5 that the pressing plate **13** facing the laminate layers to be laminated is designed in such a way that the hard brass plate **13***a* proper is surrounded by a carrier frame **13***b*, preferably an epoxy frame of equal thickness. The same applies to the heating film **14** which is held and surrounded by a corresponding carrier frame (not visible in FIG. 5).

Here, just as with respect to the structure of the other die, the individual layers preferably may be, and in fact are, bonded by double-sided adhesive films, which may be extremely thin, for example as thin as 0.002 mm.

The lower die **11***b* (see FIGS. 1–4) has a more complex design insofar as—in the case of the discussed embodiment of the invention—it includes the means permitting the relative movement between the different

layered components, for producing the desired heating and/or cooling effects.

Firstly, the lower die **11b**, i.e. the one which generally permits the relative movement of its components, also comprises a pressing plate **13'** which also directly faces the product **12** to be laminated and which likewise consists of a suitable material, for example tinned/nickel-plated hard brass, and is surrounded by an (epoxy) frame **13'a**.

At the bottom, i.e. on the side of the pressing plate opposite the laminate layers **12** to be laminated, the arrangement is—or may be—followed again by a flat heating film **14'**; and there is further provided—essentially for stability reasons—another supporting layer or supporting plate **17** which may consist of a highly heat-conducting material, for example again brass (compare FIG. 2).

The thickness of the pressing plate may be 0.3 mm, that of the flat heating film 0.1 mm, and that of the supporting plate **17** may be 0.3 to 0.5 mm.

The different layers may be pinned together by lateral pins, for example nylon pins **18a**, **18b**, and may be held in lateral guide blocks **19a**, **19b** which latter may be loosely connected to a lower cooling block **21**, which as such is known in connection with such laminating devices and which also may comprise cooling fins, as indicated by **21b**, as part of the fan cooling system preferably used in this case.

It is an essential feature that in the initial or rest position a spacing A exists between the pressing plate **13'** or—in the illustrated embodiment of the invention—between the lower supporting plate **17** provided for stability purposes, and the active area of the cooling block, the active area of the cooling block extending right to the supporting plate **17** because a cooling body **21a** extends into the space defined by the lateral U-shaped guide blocks **19a**, **19b**. In the case of the assumed and presently discussed case, this cooling body may be constituted by an integrally formed projection of the cooling block **21**. Alternatively, it may be configured as a separate cooling plate which is in highly heat-conducting contact with the cooling block **21**, for example screwed to it in flat contact, as shown in FIG. 2.

It is the basic function of such a die that during the heating subcycle the cooling body **21a**, whose cooling effect is decisively supported by the adjoining cooling block **21**—another configuration of imaginable cooling means will be described further below—is kept at a distance from the pressing zone, whereas in the subsequent cooling subcycle this distance is bridged by an upward—as viewed in the drawing—movement of the cooling body **21a** (and preferably also the cooling block **21**) by which it is moved into contact with the highly heat-conducting brass supporting plate **17**. As of the moment the heating effect of the flat heating elements **14**, **14'** has been switched off, the quantity of heat present in the laminating area is dissipated practically at once, it being without importance in this connection that the upper die **11a** does not in any way contribute to this effect, at least in the illustrated embodiment.

The described relative movement is rendered possible by the fact that the assembly which consists of the pressing plate **13'**, the flat heating film **14'** and the supporting plate **17** and is to have the least possible heat capacity and a thickness of only 1 mm, for example, is held and supported at its bottom by (heat-insulating) supporting webs **22a**, **22b** which in their turn are resiliently biased in upward direction and slidingly guided in corresponding bores **23**—which may be equipped with guide bushings **23a**—in the cooling body **21a**. In order to achieve this effect, strong supporting springs **24** may be accommodated in larger recesses **23'** in the cooling body for urging the supporting webs **22a**, **22b** in upward direction. In downward direction, the cooling body **21a** rests on the cooling block **21** (see FIG. 3).

The basic function of this die **11b**, therefore, is such that once the laminate layers **12** to be laminated have been inserted and the receiving opening has been closed, an initial pressing force is produced by moving the cooling block **21** in upward direction whereby the two pressing plates **13**, **13'** are advanced toward each other and are pressed upon the laminate layers **12** at the required pressing force. Then, the heating phase is initiated by supplying current to the flat heating films **14**, **14'**.

In the case of the practical embodiment of the invention, this upward movement of the cooling block **21** is performed in such a way that the cooling block **21** is displaced from the unstressed position, where the distance A may be equal to, say, 6 mm, to a first pressure threshold value where the springs **24** are compressed far enough to reduce the distance for example to half its value, i.e. approximately 3 mm, which has the effect that on the one hand a sufficient laminating pressure is exerted via the springs **24**, while on the other hand the distance required for the initial heat insulation of the area of the pressing zone, being now A'=approximately 3 mm, is maintained.

Upon completion of the heating subcycle, the heating zones are switched off and a second (higher) threshold pressure is exerted upon the cooling body **21a**, via the cooling block **21**, for completely overcoming the biasing force of the springs **24**. This has the result that the supporting webs **22a**, **22b** are pushed back far enough to permit the surface **21'a** of the cooling body **21a** to get into direct contact with the lower surface **17a** of the supporting plate. One thereby attains extraordinarily effective cooling, the cooling body **21a** getting into direct thermal interaction with the cooling block which, in addition to providing itself a correspondingly high refrigerating capacity, may preferably be additionally cooled by the air flow of a cooling fan.

It goes without saying, and is of course of practical use, too, that the cooling system of the cooling block and/or the associated cooling body **21a** need not be tuned to the heating and cooling subcycles performed at any time, or to the entire laminating process; if the cooling block **21** is constantly cooled by blown-in surrounding air, a perfect thermal balance is ensured for the device, the heating and cooling phases proper being tuned to the relative movement of the die components.

In the case of the discussed laminating device, the relative movement is related to pressure values because it is anyway necessary to exert a predetermined pressure on the layers to be laminated so that different distances can be adjusted without any problem, giving regard to the pressure threshold values resulting from the spring characteristics of the particular spring used.

It is of advantage if the assembly comprising the pressing plate **13'**, the flat heating film **14'** and the brass supporting plate **17**, is thermally insulated from its surroundings. To this end, thermal insulators **25**, preferably epoxy layers or strips, are provided on the lower contact surfaces of the brass supporting block **17**, in the U-shaped recesses of the lateral guide blocks **19a**, **19b** in

addition to the nylon pins by means of which the assembly is pinned in place.

According to another preferred embodiment of the present invention, the cooling effect of the cooling block **21** and the cooling body **21***a* in the area of the pressing zone is reinforced efficiently by the fact that Peltier elements or other components having a cooling effect on the cooling body **21***a*, are arranged in any position, preferably in the area between the cooling block **21** and the cooling body **21***a*. In the case of the illustrated embodiment of the invention, a Peltier element **26** is used whose cold side K faces the cooling body **21***a*, while its hot side W may, for example, be embedded in the cooling block **21** for more efficient heat dissipation. It is easily possible in this way to give the cooling body **21***a* a constant temperature; in addition, other arrangements may be made in this connection according to which current will be supplied to the Peltier element or elements **26** only when the temperature of the cooling body **21***a* differs from a predetermined target temperature, for example of 35°.

If the Peltier element **26** does not extend over the whole contact surface between the cooling block **21** and the cooling body **21***a*, then it may be useful to arrange thermal insulators **27** between the remaining surfaces, in the drawing on both sides or on all sides of the Peltier element **26**, which insulators in their turn may consist of epoxy layers or, as shown in FIG. **4**, of an epoxy frame. Such an arrangement then avoids short-circuiting of the Peltier element.

In an effort to optimize both the heating capacity and the recooling process, the supporting webs **22***a*, **22***b*, as well as the intermediate layers **25** and **27**, are configured as thermal insulators, as has been indicated before. With respect to the supporting webs **22***a*, **22***b*, this is meaningful insofar as this will prevent the heat produced from being dissipated, at least in part, via the webs during the heating subcycle.

Loose guiding of the guide blocks **19***a*, **19***b* on both sides in the cooling block **21** by means of the screw connections **20** is important in order to allow the cooling block **21** to move relative to the assembly comprising the pressing plate **13'** and the supporting plate **17**, which is pinned to the guide blocks.

Finally, an especially advantageous embodiment of the invention is obtained when the motion sequence, during which the inserted blank is laminated in the heating and cooling phase, i.e. during which pressing forces are applied via the two pressing plates and thereafter the cooling effect is activated in the cooling phase by the cooling block, is controlled at least in part without any mechanical forces, i.e. preferably pneumatically, by application of a vacuum and/or compressed air.

Referring once more to the representation of FIG. **1**, it is in any event possible in this case to do without the supporting webs **22***a*, **22***b*, and their supporting springs **24**. Instead, a vacuum is applied at least to the space defined by the two pressing plates **13** (upper die—FIG. 5) and **13'** (lower die—FIG. 1), after insertion of the blank and appropriate sealing, with the result that the two pressing plates—and the other layers combined therewith, i.e. the heating film, pressure-compensation layers, supporting plates, and the like, in which the dies are guided—will be pressed together at a sufficiently high pressure, due to the vacuum introduced between these two components of the assembly, so that the heating subcycle, and molding of the blank, can be carried out under the effect of the required temperature.

Working with pneumatically controlled motions provides the additional, particular advantage that the vacuum between the two areas of the assembly—of which one at least should be guided for displacement in the die so as to permit the required movement under the effect of the vacuum—will of course also influence the inserted blank, with the result that the latter is given an especially perfect, excellent appearance. This is due to the fact that, for example, any disturbing phenomena produced by air, such as bubbles, bulges, or the like, which otherwise cannot be excluded in such laminating processes, are absolutely excluded, the vacuum having of course the simultaneous effect that any air bubble, or trapped air, will be positively extracted, i.e. removed. This is a particular advantage for high-finish laminations.

The laminating process, thus, operates as follows: Once the blank has been inserted between the two dies of the pressing tool, and the dies have been closed, a vacuum is applied to the inner area of the dies so that due to the surrounding air pressure, which continues to act on the pressing plate assemblies, the necessary pressing force is made available for lamination, simultaneously with the required heat.

Upon completion of the heating subcycle, the heat is carried off rapidly, as has been described before, due to the fact that cooling surfaces are applied to the respective assembly comprising the pressing plate, heating film, supporting plate and the like. Preferably, this action occurs only in the lower die, but if desired it may be arranged for in the upper die, too.

The sequence of motions just described may also be pneumatically controlled, for example by the action of the vacuum anyway present. To this end, suitable valves that are activated at the moment of transition from the heating subcycle to the cooling subcycle are used to open the vacuum area to the top or to the bottom beyond the respective pressing plate assembly so that a suction force is applied to the cooling body, too; the simple establishment of contact already ensures a sufficient degree of heat transfer, without the need to exert additional higher pressing forces.

Alternatively, however, there is also the possibility to exert an (additional) external pneumatic overpressure on at least the lower cooling area in the pressing tool—or on both cooling areas, if provided, in which case the pressure so generated may be higher than the external atmospheric pressure maximally achievable under the effect of the applied vacuum.

There is, however, also the possibility to make use of rocking levers, magnetic effects, or spring forces or of a combination of such forces, for applying the cooling blocks and/or the cooling body plates to the respective pressing plate assembly at the moment of transition to the cooling subcycle.

Except for the necessary sealing means which can, however, be safely controlled if a sufficiently high vacuum is generated, choosing a pneumatic control for the pressing plate and the cooling body components also leads to a significant simplification of the structure of such a laminating device, as in this case a plurality of pressure webs, biasing springs, and the like can be omitted.

An alternative configuration of the mechanical structure, with spring-biased pressing assembly according to FIGS. **1** and **2**, may finally provide that the pressure

webs 22*a*, 22*b* are omitted, and the biasing spring means are located closer to the outside, i.e. to the marginal area. Advantageously, one may make use in this case of the fastening means (for example screws) 20, by providing them, for example, in the bores of the guide blocks, in coaxial arrangement with biasing springs in a manner such that the pressing assembly 13', 14', 17 is urged in upward direction. This is of advantage also because the sensitive laminating area is kept free in this case of any mechanical pressure means.

Lastly, it should be mentioned that the claims, and especially the main claim, are attempts at putting the invention into words without limiting prejudice. The right to regard all features presented in the description, the claims, and the drawings, both individually and in any combination, as essential to the invention, and to record them in the claims, is therefore reserved.

I claim:

1. Method for laminating layers consisting at least in part of thermoplastic films, for producing identification cards, check cards, identity cards, credit cards, or the like, carrying data, where an inserted blank is subjected to the action of pressure and heat by a pressing tool die arranged on at least one side and comprising heating and cooling means, wherein after insertion of the blank between the dies, the blank undergoes a heating phase in which the blank is subjected to the pressure and heat required for complete lamination of the blank, while heat dissipation is prevented by the fact that cooling components are kept at a predetermined distance from the pressing and heating components of the die or dies involved in the laminating step, whereafter the heating effect is switched off and the blank undergoes a cooling phase in which a cooling body is brought into contact with the assembly of pressing and heating components of a die involved in the laminating step whereby the temperature of the laminated product, which has been finished during the heating phase, is reduced to its proper removal temperature.

2. Method according to claim 1, wherein during the heating phase the cooling body is moved from an unstressed initial position, under the effect of pressure, into a position (A') at a smaller distance from the assembly of pressing and heating components, and is then, during the cooling phase, urged upward and into contact with the assembly until the spacing equals zero.

3. Method according to claim 1, wherein the assembly, which comprises a pressing plate (13') adjoining the layers (12) to be laminated, a flat heating film (14') adjoining the pressing plate and an additional lower, highly heat-conducting supporting plate (17), is maintained by spring action at an insulating spacing from the cooling body, whereby the necessary pressing force for the laminating process is simultaneously produced, and wherein the said spring pressure between the assembly and the cooling body (21*a*) is then fully overcome during the subsequent cooling phase and heat-conducting contact is established.

4. Method according to claim 3, wherein during the heating phase the assembly comprising the pressing plate (13'), the flat heating film (14') and the supporting plate (17) is kept in spaced relationship to its surroundings, including its supporting elements, by heat insulators and is brought into full-surface contact with the cooling body (21*a*) by a relative movement during the subsequent cooling subcycle.

5. Method according to claim 1, wherein a vacuum is applied to the space between the two pressing dies, in which the blank is accommodated, so that during the heating phase the pressing and heating components involved in the laminating step are pressed against the blank in order to exert a pressing and heating effect.

6. Method according to claim 5, wherein while maintaining the vacuum, the effect of the vacuum is extended also to the cooling body so that the body is urged into heat-conducting contact with the assembly of pressing and heating components.

7. Method according to claim 5, wherein compressed air is applied externally upon the cooling body, which initially had been maintained in spaced relationship to the assembly of pressing and heating components, whereby the cooling body is moved into contact with the pressing and heating components.

8. Method for laminating layers consisting at least in part of thermoplastic films, for producing identification cards, check cards, identity cards, credit cards, or the like, carrying data, where an inserted blank is subjected to the action of pressure and heat by a pressing tool die arranged on at least one side and comprising heating and cooling means, wherein after insertion of the blank between the dies, the blank undergoes a heating phase in which the blank is subjected to the pressure and heat required for complete lamination of the blank, a vacuum being produced in the space between the dies while the space is sealed from the outer atmosphere so that the assembly of pressing and heating components of a die involved in the laminating step are pressed against the blank by external air pressure in order to apply pressure and heat to the blank.

9. Method according to claim 8, wherein the heating effect is switched off and the blank undergoes a cooling phase in which a cooling body is brought into contact with the assembly of pressing and heating components, the cooling body being maintained at a predetermined distance from the assembly during the heating phase to prevent heat dissipation, and the cooling body being moved into contact with the assembly by applying a vacuum to the cooling body.

10. Method for laminating layers consisting at least in part of thermoplastic films, for producing identification cards, check cards, identity cards, credit cards, or the like, carrying data, where an inserted blank is subjected to the action of pressure and heat by a pressing tool die arranged on at least one side and comprising heating and cooling means, wherein after insertion of the blank between the dies, the assembly of pressing and heating components of a die is urged towards the blank so that the blank undergoes a heating phase in which the blank is subjected to the pressure and heat required for complete lamination of the blank, the heating effect being switched off and the blank thereafter undergoing a cooling phase in which a cooling body is urged towards the blank and into contact with the assembly of pressing and heating components, at least one of the assembly and the cooling body being urged towards the blank by directly applying positive air pressure, or positive air pressure and vacuum, thereto.

* * * * *

(12) UK Patent Application (19) GB (11) 2 225 283 (13) A

(43) Date of A publication 30.05.1990

(21) Application No 8823576.7

(22) Date of filing 07.10.1988

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(51) INT CL^4
B42D 15/02 15/10, G06K 19/06 19/077

(52) UK CL (Edition J)
B6A AC91 AK

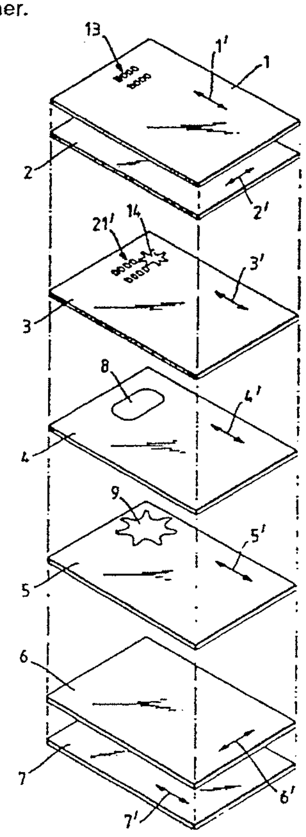
(56) Documents cited
EP 0268830 A

(58) Field of search
UK CL (Edition J) B6A AK
INT CL^4 B42D
Online database : WPI

(54) **Laminated IC card**

(57) A laminated, integrated circuit (IC) card comprises a number of plastics layers (1-7) laminated together and supporting an IC element (8). Some of the plastics layers (1-7) exhibit a grain structure and at least two of the layers (2, 3); (5, 6) are oriented with their grain directions transverse to each other.

Fig. 1.



At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

The claims were filed later than the filing date within the period prescribed by Rule 25(1) of the Patents Rules 1982.

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Fig.1.

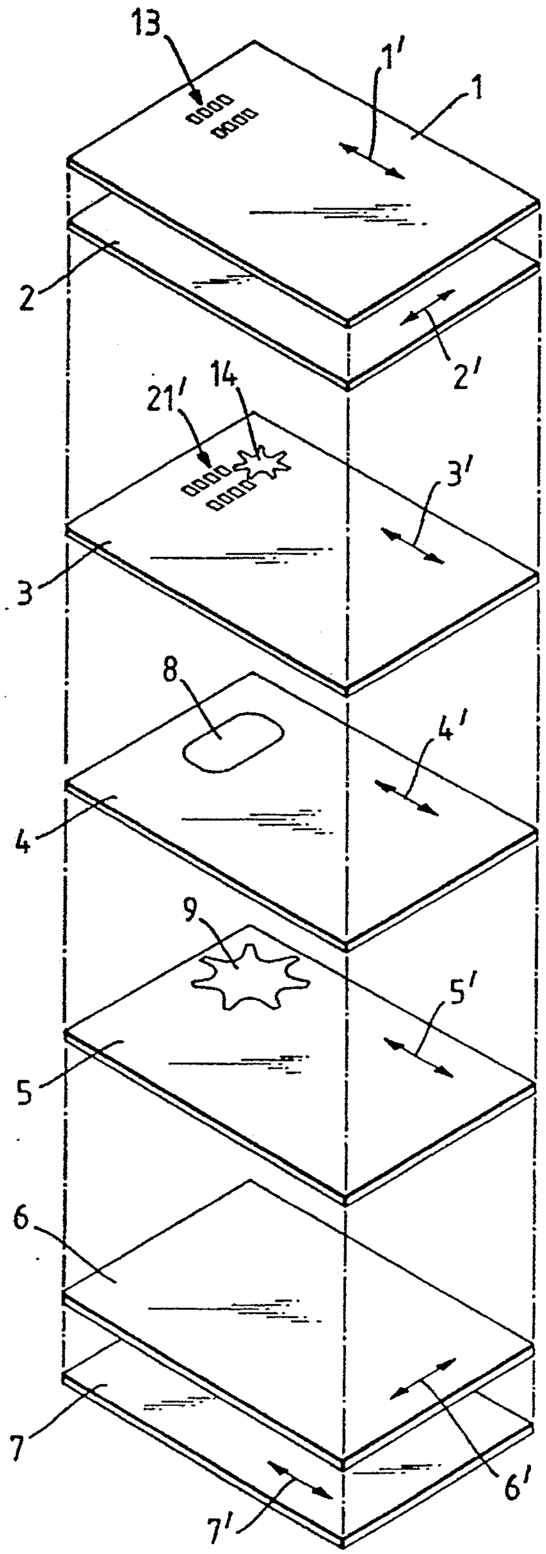
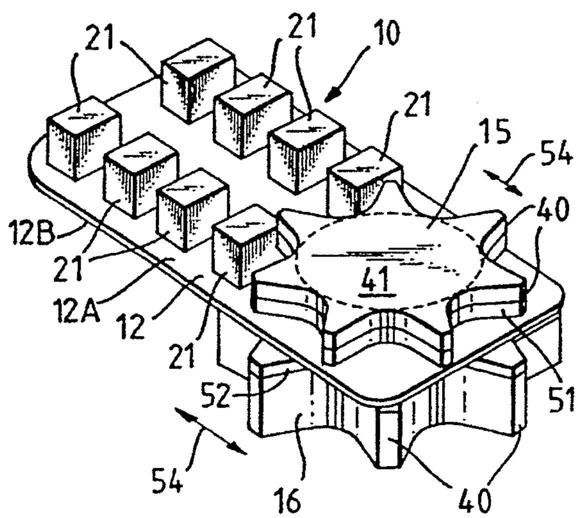

13
1'
1
2
2'
21'
14
3'
3
8
4'
4
9
5'
5
6
7
6'
7'

Fig.2.


21
21
10
21
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54
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12B
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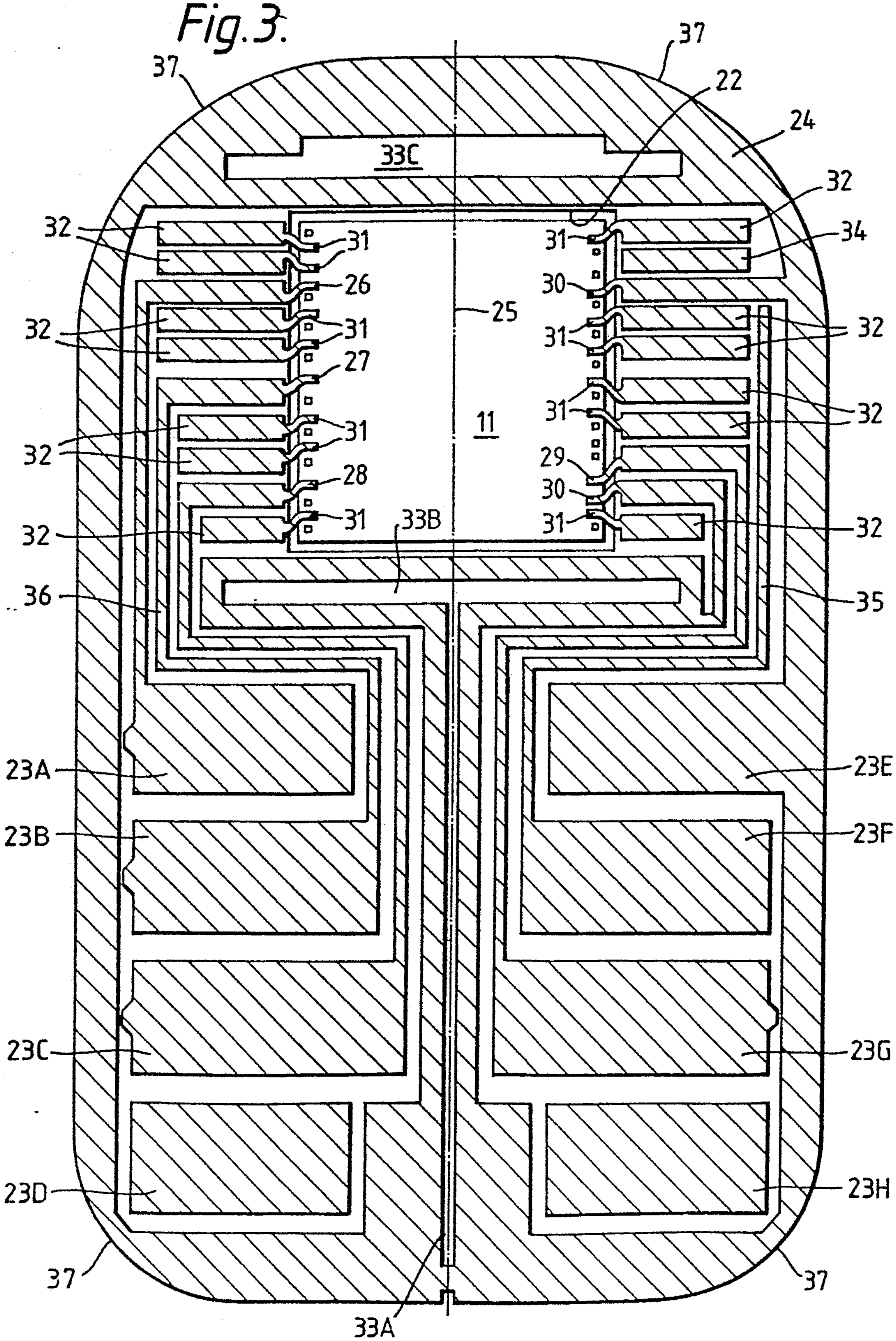
41
12A
12
21
52
51
54
16
40

Fig.3.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37
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30
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23G
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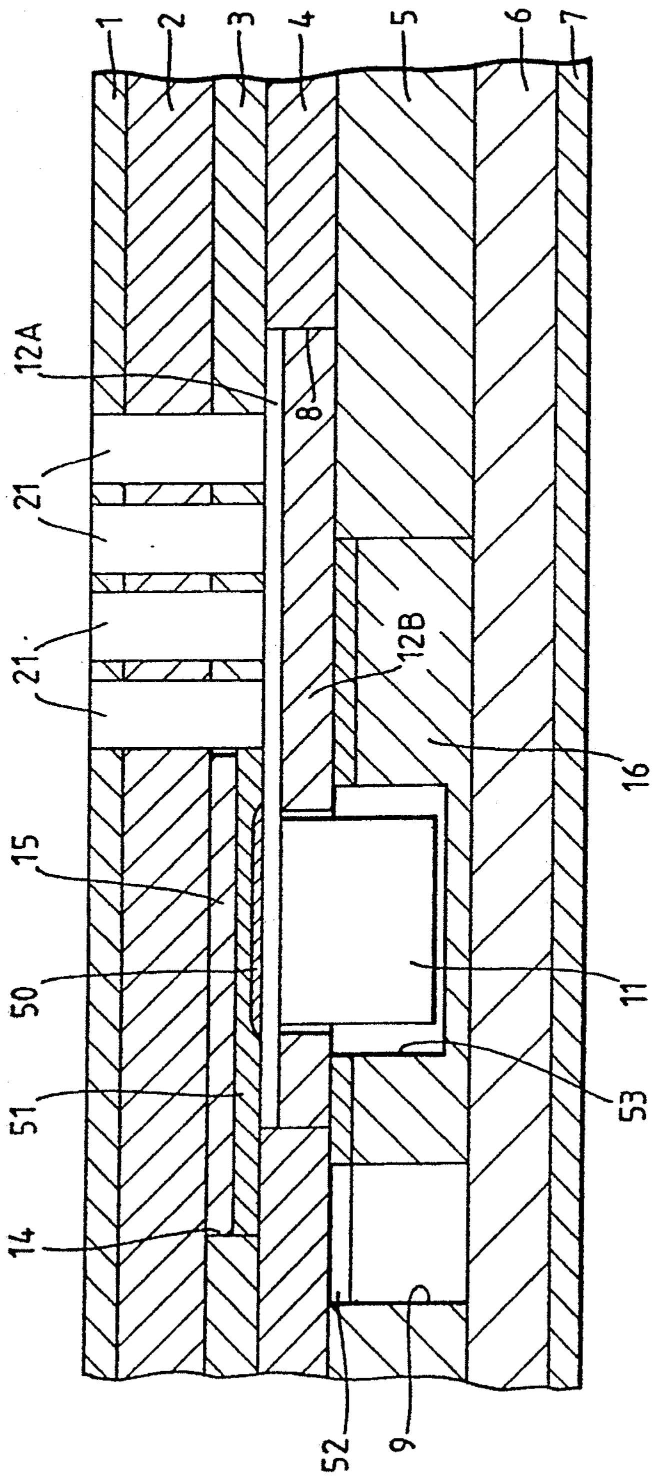
23H
37
37
33A

Fig. 4.



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LAMINATED IC CARD

The invention relates to a laminated integrated circuit (IC) card comprising a number of plastics layers laminated together and supporting an IC element. Such a card is hereinafter referred to as of the kind described.

Cards of the kind described are being used in a wide variety of fields, for example as credit and charge cards as well as identification cards and the like. These cards include an IC element, typically a single chip microprocessor, which in most cases is mounted to a carrier element to form an IC carrier assembly. This assembly is then laminated into the plastics layers. One of the problems with these cards is that during use they undergo significant flexure which can cause some of the layers to crack and possibly also damage the IC element.

According to the present invention, we provide a laminated IC card of the kind described in which at least some of the plastics layers exhibit a grain structure, and wherein at least two of these layers are oriented with their grain directions transverse to each other.

Typical IC cards have a generally rectangular form and it has been found that the resistance to flexure and hence the likelihood of cracking varies between the short and long dimensions of the card. We have found that this can be improved upon by taking account of the inherent grain structure of certain plastics layers. Thus by orienting at least two of the layers with their grain directions transverse, the susceptibility to cracking is reduced.

The grain structure originates from the method of manufacture of the layers in which the layers may be rolled and calendered causing some degree of molecular alignment within the plastics materials.

Preferably, the grain directions of the two layers are arranged orthogonally to each other.

In one example, a majority of the plastics layers which exhibit a grain structure are arranged with their grain directions substantially parallel with a minority of the plastics layers exhibiting a grain structure having their grain directions transverse to the one direction.

Since the stiffness of a layer increases with the third power of the thickness, it is preferable if one of the said two layers is chosen from the thickest layers. Typically, the thickest layers are those which normally carry printed information.

Typically, the plastics layers comprise PVC although other types of plastics such as PVCA could be used.

In a further improvement, the card may further comprise at least one stress reduction member positioned in alignment with the IC element and having a grain direction oriented substantially parallel to the grain direction of at least one of the plastics layers. The use of a stress reduction member is described in more detail in our copending European Patent Application entitled "Integrated Circuit Card" (Agents Ref:30/2470/02) filed on even date and in the preferred example this member is in the form of a star-shaped, metal member.

In one construction, the grain directions of alternate plastics layers alternate between one of two transverse directions.

An example of an integrated circuit card in accordance with the present invention will now be described with reference to the accompanying drawings, in which:-

Figure 1 is an exploded view of the card;

Figure 2 is a perspective view of the IC module;

Figure 3 is a plan of the conductor pattern provided on the carrier element of the IC module; and,

Figure 4 is an enlarged cross-section through part of the card.

The integrated circuit card comprises a laminate, as shown in Figures 1 and 4, having a number of plastics layers 1-7. The plastics layers 1-7 typically comprise PVC, PVCA or similar materials. The thickness of these layers is set out in Table 1 below.

TABLE 1

Layer Number	Pre-lamination Thickness(μm)
(1)	60
(2)	150
(3)	120
(4)	120
(5)	250
(6)	150
(7)	60

After lamination, the total thickness of the card will reduce to about 780μm.

Each layer has a grain due to the method of manufacture in which the sheets are rolled and calendered causing some alignment of the molecular structure. Consequently, each layer is "stiffer" across the grain than along the grain. The grain direction of each layer is indicated in Figure 1 by arrows 1' - 7' respectively and it will be seen that the grain direction of layers 2 and 6 is transverse to that of the remaining layers. These layers 2,6 are typically opaque and carry printing on their outwardly facing surfaces. Due to their thickness relative to the other layers and their positions towards the outside of the card there is a significant risk of cracking of these two layers when the

card is bent in its short dimension, if the grain of these layers were in the long dimension. The reason for changing the grain direction in these layers is that this leads to a card in which there is a much lower risk of cracking of the printed layers. Also, a generally similar degree of resistance to flexure in all directions is achieved. These improvements lead to a longer lifetime. If all the laminae were to be laid with the grain in the same direction, then the result would be a "stiff" card in the axis across the grain. This is undesirable since, from a bending/torsion viewpoint, it is preferred that the card is equally flexible in all directions relative to the "stress reduction" members of the IC Module (to be described).

In the case of plastics layers 1-7 formed by rolling and/or calendering, the "grain" is considered to extend in the long direction of the forming process, ie. the direction of movement of the plastics through the forming apparatus. Typically, this is the predominant direction of shrinkage when the plastics is subjected to heat.

Embedded within the card is an IC module 10 (Figure 2) consisting of a chip 11 defining a single chip microprocessor such as the Hitachi 65901 mounted to a chip carrier 12 formed by a layer of copper 12A on a polyimide layer 12B such as Kapton to define a carrier assembly. The chip carrier 12 is received in an aperture 8 of the layer 4. As will be explained in more detail below, a pair of star shaped stress reduction members 15, 16 are embedded in apertures 14, 9 respectively of the layers 3, 5 in alignment with the chip 11.

As will be explained in more detail below, contacts on the chip 11 are coupled via conductors of the copper layer 12A on the chip carrier 12 with contact members 21

which protrude through the layers 1-3 to allow physical contact with a card reader.

In the finished card, the layers 1, 7 are transparent to allow the printing on layers 2, 6 to be read by the user.

The module shown in Figure 2 is constructed as a separate unit which is then laminated with the layers 1-7. The chip carrier 12 is cut from a Kapton (polyimide) substrate 12B (thickness 75μm) on which is provided the layer 12A of copper foil (thickness 35μm) adhered by an epoxy to the Kapton layer 12B. The copper is etched to provide a conductor pattern shown in more detail in Figure 3. In addition the Kapton is punched to provide an aperture 22 in which the chip 11 is received.

It will be seen in Figure 3 that the conductor pattern defines eight contact pads 23A-23H to which the contact members 21 are individually bonded. In addition, the conductor pattern has an outer ground plane 24 extending around the pattern. It should be noted that the contact pads 23A-23H are substantially symmetrically arranged about a line of symmetry 25.

The contact pad 23A is connected with a functional contact 26 of the chip 11; the contact pad 23B is connected to a functional contact 27 of the chip; the contact pad 23C is connected to a functional contact 28 of the chip, and the contact pad 23G is connected to a functional contact 29 of the chip 11. Two functional contacts 30 are connected to the ground plane 24 as is the contact pad 23E. Contact pads 23D, 23F and 23H are isolated.

In addition, a number of non-functional contacts 31 of the chip 11 are connected to respective, short conductors 32 of the conductor pattern such that the arrangement of the conductor pattern adjacent to the chip

11 is substantially symmetrical about the line of symmetry 25. In addition, an isolated conductor 34 is provided to complete the symmetrical arrangement.

In this case, it will be seen that the conductor pattern is bonded to ten contacts of the chip 11 on the left hand side of Figure 3 and nine contacts on the right hand side. This small difference in the number of bonded contact positions is acceptable and the term "substantially symmetrical" should be interpreted accordingly. This substantially symmetrical arrangement of contacts connected to conductors allows the chip 11 to be securely supported in the aperture 22 of the carrier 12 and reduces the risk of undue twisting of the chip 11 within the aperture 22, whilst allowing some freedom of movement of the chip relative to the chip carrier 12. This freedom of movement is necessary to prevent damage to the chip and its connections during manufacture of the IC module 10, during lamination of the IC card, during subsequent use of the IC card. Undue twisting of the chip 11, in the aperture 22, relative to the chip carrier 12 could result in excessive stresses at the IC connections.

The remainder of the conductor pattern is also substantially symmetrical about the line of symmetry 25. In this connection, it should be noted for example that although the contact pad 23F is not connected to the chip 11, a conductor line 35 extends from the contact pad 23F to a position adjacent the chip 11 in a similar way to a conductor line 36 which extends from the contact pad 23B to the contact 27. This assists in overcoming the natural tendancy of the copper layer 12A to distort, which can otherwise weaken the bonds between the conductors and chip contacts before lamination, during lamination, and to some extent after lamination.

In addition, the copper pattern 12A is split at 33A, 33B, 33C to reduce its rigidity, so that the chip carrier 12 will more readily flex when card flexure occurs. The copper pattern is split at 33A along the line of symmetry 25, copper is etched away from a section 33B orthogonal to and communicating with the section 33A, copper is also etched away from a section 33C.

The corners 37 of the carrier 12 are rounded to help to reduce stress concentrations in the card layers at the corners of the carrier.

In constructing the module, the first step is to form the conductor pattern described above. The next step is to bond the contact members 21 to the contact pads 23A-23H.

Following this step, the IC chip 11 is located in the aperture 22 and the chip contacts are bonded to the inner ends of the conductors which overlie the aperture 22, as shown in Figure 3 and as previously described. The method chosen is Tape Automated Bonding (TAB). TAB is preferred to wire bonding since (relative to wire bonding) it provides higher bond strength, greater reliability, improved mechanical construction, and a thinner package.

TAB requires that the IC chip 11 should have its contacts "bumped" to a specified height and consistency to allow for the inner lead bonding of the chip to the carrier. The bumping normally comprises the deposition of gold onto the aluminium contacts of the chip.

After the bonding operation, a resin (polyurethane) coating 50 (Figure 4) is applied to the surface of the IC chip 11 and the inner lead bonds so as to provide for mechanical and optical protection for the chip contact/conductor bonds prior to lamination. This coating 50 is known as the "glob top".

The two star shaped members 15, 16 are then bonded to the chip carrier 12. These members 15,16 are metal and are consequently stiffer than the plastics layers 1-7. The members 15, 16 locally stiffen the card body around the chip 11, they provide a strengthening reinforcement to protect the contact/conductor bonds. The members 15, 16 are stress reduction members reducing the mechanical stresses to which the contact/conductor bonds are subject during card lamination and during card use. To avoid abrupt changes in the card stress conditions, introduced by the members, at the boundaries of the members with the card laminae a "star" shape is adopted as shown in Figure 2. The star profile provides a gradual increase in stiffness from the outer boundary of legs 40 of the star to a central section 41 indicated by a dotted line.

It should be noted that the "stiffness" of a circular plate varies inversely as the square of the diameter and directly as the cube of the thickness.

The members 15, 16 are mounted above and below the chip 11 and it is considered advantageous not to bond the members to the laminate in order to allow relative movement between the members and the laminate during flexing and twisting of the card.

The members 15, 16 are affixed to the chip carrier 12 via respective flexible double-sided adhesive tapes 51, 52 although other forms of flexible bonding could be used. However, it is important that the method used to bond the upper member 15 to the chip carrier 12 is electrically insulating since the upper member 15 contacts the conductor pattern.

In this example the upper member 15 is made of hard-rolled brass and has a thickness of about 50µm. The lower member 16 is made of hard-rolled brass with a thickness of about 150µm. The thicker lower member 16

enables an air pocket to be provided around the chip 11 by providing a machined recess 53 (Figure 4) to accommodate that portion of the chip 11 which protrudes below the chip carrier 12.

In other examples, other metals such as stainless steel or coppernickel alloy could be used. In addition the upper member 15 could be in a different metal such as stainless steel to the lower member 16 such as brass. Furthermore, the lower member 16 could be formed similar to the upper member 15 with a thickness of about 50µm and without a recess. In this case the resulting space would be filled with a suitable material such as a double sided adhesive tape, which will allow a cavity to be formed to accommodate that portion of the chip 11 that protrudes below the chip carrier 12 and, furthermore which will allow a flexible bonding to the lower member 16 and to the chip carrier 12.

It has been found that it is not necessary to cut an aperture in the double-sided adhesive tape 51 used to attach the upper member 15 to accommodate the glob-top 50 since the tape is sufficiently flexible to allow the glob-top to be impressed into it (during card lamination).

It should be noted that in the case of the members 15, 16 both being of the same thickness of about 50µm then the typical thickness of each double-sided tape is 85µm for the upper member and 200 µm for the lower member 16. It should be noted that in the case of the upper member 15 having a thickness of about 50µm and the lower member 16 having a thickness of about 150µm then the typical thickness of each double-sided tape is 85µm for both members15, 16.

It will be noted that each member 15, 16 has an odd number of legs 40 (in this example 7) so as to avoid an "axis of stress" being set up in the card laminae and

extending through the star centre. This also allows the legs 40 of the upper member 15 to fit conveniently with the contact members 21.

In this example, the diameter of the central section 41 of the upper member 15 is made to correspond to the diagonal dimension of the chip 11, for example 9mm and the outer boundary (defined by the tips of the legs 40) is 13mm to suit the width of the chip carrier 12 and the contact arrangement. For the lower member 16, the central section is made to correspond to the width of the chip carrier 12 and has a diameter of about 15mm and the outer boundary is made to suit the card boundaries with a diameter of about 21mms.. Preferably, the two members 15, 16 are positioned so that the legs 40 do not align, in order to avoid possible stress concentrations.

In most examples, each member 15, 16 will have a constant thickness but in some cases, some tapering could be provided from the inner annulus towards the legs.

The completed module 10 (Figure 2) is then assembled with the PVC card layers 1-7 within which it is to be laminated. The module is located in a punched aperture 8 in the layer 4 which is shaped to conform to the chip carrier 12. The layer 5 has a punched star-shaped aperture 9 conforming to the lower member 16 while the layer 3 has a punched aperture 14 having a star-shape conforming to the upper stress reduction member 15 and a set of eight punched apertures 21' through which the contact members 21 protrude. In addition, the layers 1, 2 have sets of eight punched apertures, one set of which is shown at 13 through which the contact members 21 extend so as to finish substantially flush with the outer surface of the layer 1.

It will be noted that the orientation of the chip carrier 12 is transverse to the long axis of the layers

1-7. This orientation is best, from the point of view of card bending/torsion.

The assembled pre-laminate including the module is then laminated using conventional lamination machinery (heated presses). The normal (plastic identification card) lamination technique is to place the lamina build-up into a pre-heated press and immediately apply full pressure (compressing the lamina sheets together). In an alternative method, the applied pressure is gradually increased. For example, the press may be pre-heated to 140°C and then pressure applied in steps. Finally, the laminate is cooled for about 10 minutes with the pressure maintained at its highest value.

It is important that during the lamination process the chip 11 and the contact/conductor bonds are not subjected to undue compressive stresses due to bending. The silicon material has a compressive breaking stress of 15000 lb per square inch but the tensile breaking stress is only 3000 lb per square inch.

The members 15, 16 provide the major resistance to undesirable tensile stresses within the chip 11 and the contact/conductor bonds but in addition use is made of the "pocketing" of the chip in an air filled cavity as defined by the machined recess 53 in the lower member 16. This is because the surrounding gas (air) is readily compressible and will therefore transport the compression forces during laminating uniformly to the chip without subjecting the chip 11 to undesirable tensile stresses due to bending.

The preferred stress reduction members 15, 16 are made from metals, such as hard-rolled stainless steel and brass which exhibit a grain. This causes the members to take up a natural curvature, due to the hard rolling method, which is "memorised" even when the member is flattened. To optimise performance, therefore, it is

preferred if this grain extends across the card, that is parallel with the short dimension of the card, while the natural bow or curvature of both members 15, 16 is outwardly of the card. The grain direction of the members 15, 16 is indicated in Figure 2 by arrows 54.

CLAIMS

1. A laminated, integrated circuit (IC) card comprising a number of plastics layers laminated together and supporting an IC element, in which at least some of the plastics layers exhibit a grain structure, and wherein at least two of these layers are oriented with their grain directions transverse to each other.

2. A card according to claim 1, wherein the grain directions of the two layers are arranged orthogonally to each other.

3. A card according to claim 1 or claim 2, wherein a majority of the plastics layers which exhibit a grain structure are arranged with their grain directions substantially parallel with a minority of the plastics layers exhibiting a grain structure having their grain directions transverse to the one direction.

4. A card according to any of the preceding claims, wherein the plastics layers comprise PVC.

5. A card according to any of the preceding claims, further comprising at least one stress reduction member positioned in alignment with the IC element and having a grain direction oriented substantially parallel to the grain direction of at least one of the plastics layers.

6. A card according to claim 5, wherein the or each stress reduction member comprises a star-shaped, metal member.

7. A card according to any of the preceding claims, wherein the grain directions of alternate plastics layers alternate between one of two transverse directions.

8. A laminated, integrated circuit card substantially as hereinbefore described with reference to the accompanying drawings.

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